A PRACTICAL TREATISE ON MECHANICAL DENTISTRY

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SEVENTH EDITION

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MANY OF WHICH ARE FROM NEW AND ORIGINAL DRAWINGS

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To

THE MEMORY OF THE LATE

JAMES TAYLOR, M.D., D.D.S.,

FORMERLY EMERITUS PROFESSOR OF THE INSTITUTES OF DENTAL SCIENCE
IN THE OHIO COLLEGE OF DENTAL SURGERY,

AS AN

ACKNOWLEDGMENT OF PROFESSIONAL EMINENCE
AND PRIVATE WORTH,

This Volume is gratefully inscribed,

BY

HIS FORMER PUPIL,

THE AUTHOR.

NOTE.

In preparing the seventh edition of this work, the editor's effort has been to make it preëminently practical as a text-book for students, and a guide for young practitioners,—an exponent of the present status of dental prosthesis. Much of the text has been rewritten; three new chapters, new appliances, and systems have been introduced; while useless methods and obsolete theories have been eliminated, thus keeping the dimensions of the book convenient and compact.

The editor desires to acknowledge his indebtedness to the writings of Professors Wilbur F. Litch, C. J. Essig, L. P. Haskell, and Drs. George Evans, James W. White, Eben F. Flagg, John Allen, Theo. F. Chupein, and others.

Geo. W. Warren.

Philadelphia, April, 1897.

PREFACE TO FIFTH EDITION.

The demand for a fifth edition of the present work, following closely upon the publication of the one immediately preceding, affords gratifying assurance of the profession's recognition of the treatise as a trustworthy exponent of the present status of prosthetic dentistry as illustrated in the practice and teachings of its representative members.

Not less obviously does it furnish proof of an increasing interest in a department of dental practice that has amply vindicated its claim to rank as a *conservative* branch of the healing art; a distinction due, in large part, to the introduction and growth of more or less perfected systems of root-crowning and bridge dentures—systems involving processes of repair and methods of curative treatment that do not suffer by comparison with those practised at the chair in the important work of restoring to usefulness organs whose natural functions have been impaired or wholly subverted by the ravages of decay.

It is a suggestive fact, commended to the consideration of those who characterize prosthetic dentistry as essentially "mechanical," and who seek to disparage the professional and scientific qualifications necessary to success in this department, that the results achieved by the conservative methods alluded to have been reached *only* through a critical study of tooth-structure and function, a familiar acquaintance with pathological conditions associated with diseased teeth and implicated tissues, a comprehensive knowledge of the curative resources of dental therapeutics, a broad and intelligent apprehension of principles underlying mechanical devices, and a marvelous development of ingenuity and manipulative skill.

For obvious reasons, therefore, large space is given to the consideration of these systems of crown replacement, the value and importance of which command, at this time, general and deserved recognition. Subjected to the crucial tests of time, and amenable

to the inexorable verdict of experience, many of them, doubtless, will at no distant day take their place "down among the dead men," while others, in obedience to the operation of laws that determine the "survival of the fittest," will live and take a fixed place among other humane devices that have proved lasting benefactions to mankind.

Without indicating specifically the supplemental contributions incorporated in this edition, it will be sufficient to state that the work has been materially enriched by the introduction of special methods of substitution, and various laboratory appliances, so conspicuously meritorious that they may properly be said to mark an era in the development of prosthetic practice.

JOSEPH RICHARDSON.

TERRE HAUTE, IND.

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A TREATISE

ON

MECHANICAL DENTISTRY.

INTRODUCTION.

Before entering upon a detailed account of the agencies, processes, and methods appertaining to the department of dental practice to which this work relates, some general reflections may not be inappropriate.

It is not the purpose of the writer to unduly magnify the claims of prosthetic dentistry upon the regard and consideration of the profession. A just estimate of the nature of its requirements, and the results contemplated in its practice, as well as the abundance and sufficiency of its resources in the accomplishment of its high and humane purposes, will, it is believed, amply vindicate its importance, its possibilities, and its beneficence as a department of practical dentistry having intimate relation to the necessities of the unfortunate.

The untimely or premature loss of the natural teeth may be ascribed to a number of diverse causes. Multitudes are lost in consequence of abuse or neglect, or the dread of pain so commonly associated with the means employed in their preservation; many from unavoidable accident; and countless numbers are sacrificed through the incompetency and dishonesty of ignorant and unscrupulous operators who, in one guise or another, infest and prey upon communities.

Nor can we exclude from this list of causes another source of loss which, by implication, declares the impotence of the profession's curative resources in the absolute conservation of these

important organs. Whatever sense of humiliation may attend the statement, it is nevertheless true that the highest attainable skill directed to the permanent preservation of the natural teeth must, in the very nature of things, often prove inadequate and abortive, for no proposition is more broadly or more generally recognized by intelligent practitioners than that conservative practice has its limitations growing out of conditions associated with individual organisms and environments wholly beyond the control of the operator. Whatever triumphs (and they are many and conspicuous) modern conservative dentistry may have achieved in the way of narrowing the field of prosthetic practice, the prophecy, born of hope, that the time will come when the utmost resources of human skill will, in respect of the teeth, be able to exempt mankind wholly from the penalties of transgressed law, is as Utopian and delusive as the faith that prophylactic or preventive medicine will ultimately eradicate every form of disease that at present afflicts mankind. They are alike the dreams of enthusiasts and visionaries. Physical infirmity, in one form or another, is the heritage of the race, and human skill, however well directed or conscientiously and intelligently administered, can do little more than mitigate the "pains and penalties" of the primal curse that rests upon all.

It is the peculiar and distinctive prerogative of prosthetic dentistry to devise and perfect means for the amelioration of the condition of those who, from whatever cause, have suffered one of the gravest forms of mutilation in the loss of organs so essential to the healthful performance of many important functions. In this special field of humane endeavor the highest order of qualification is imperatively demanded for the complete fulfilment of its diversified and complex requirements. No one can be said to be properly equipped for its duties who has not a more or less familiar acquaintance with such of the several branches of Physics and Natural Philosophy as relate in any manner to his special work, while an exact knowledge of the Anatomy, Physiology, and Pathology of the tissues or structures in any way related to the substitute is absolutely indispensable. Added to such qualifications is the essential requirement of the highest order of manipulative skill. But beyond all these qualifications, and supplementing them, is that art culture which is the crown and inspiration of all perfect work in every form of substitution, and without which the

best results of mere handcraft are, in the main, but little better than libels and caricatures. In no other department of practical dentistry is the art instinct so strongly appealed to, or so imperiously demanded as a condition of the highest success. Dr. Eben M. Flagg, in an essay on Dental Art, very aptly says: "There is an element which enters into the conception and execution of every branch of our labor, and more or less forms part of every operation that we are called upon to make, be it surgical, operative, or prosthetic. This element lightens our drudgery, enlarges our souls, gives individuality to our work, and brings satisfaction to ourselves that fully repays the time spent in fulfilling its requirements. It was born with our race, and has inseparably accompanied every movement that has brought comfort and happiness to man. It has contributed its share toward raising the physician from a mere 'bleeding, physicking, leeching' animal, to the position he occupies to-day, and has shown the mechanic and inventor that, if he would be great, he must be more than an artisan; he must be an artist. This element—the element of art—whenever it enters the field of human life, has for its function to finish and render attractive the hard labor that preceded it. Thus, we do not find it in its full manifestation except in those departments of labor which have attained scientific certainty."

Among the unnumbered millions of human beings who have peopled the earth since the dawn of time, it may be affirmed that no two have been created with faces exactly alike. There is the same aggregate of features, and a pervading general resemblance of one person to another, but there will be found as infinite a multiplication of distinct shades of facial expression as there are human faces, and each separate shade of expression characteristic of each one, and distinguishing him or her from all others, constitutes facial individuality. Each separate feature—as the eye, the nose, the mouth, the teeth, facial contour, complexion, temperament, etc.—contributes to this individuality, and no one special feature more, perhaps, than the teeth. There are few more repulsive deformities than those inflicted by the loss of these organs, and none more fatal to the habitual and characteristic expression of the individual. It is the special mission, as it is the first and highest duty, of the dentist to preserve this individuality intact, and an equally imperative duty to restore it as perfectly as possible when impaired. To

fulfil, in the most perfect manner possible, this most difficult of all the requirements of prosthetic practice implies an art culture that is competent to interpret the distinct play of features associated with individual physiognomies, to differentiate individual temperaments, and make available the sculptor's and painter's perceptions of the subtle harmonies of form and color.

To the failure or inability to properly comprehend the practical import or significance of individual characteristics, so far as they find expression in the teeth, and the consequent failure to conform our methods of replacement to the imperative requirements of art, may be fairly ascribed the deserved reproach into which prosthetic practice has fallen, and not, as is generally charged, to the employment of any particular material or methods concerned in the mechanical execution of the work.

There is no material classed among the so-called "cheap bases" that does not embody art possibilities far beyond what is being continually illustrated in general practice. Unquestionably they are not the best for the purpose, but they may be greatly enhanced in value, and rendered more deserving of professional favor, if utilized in conformity with the esthetic requirements imperatively demanded in all forms of substitution.

There is an ethical phase of this subject which must enter as an element into the profession's estimate of the suitableness of these inferior forms of replacement—a question of obligation and responsibility involving a problem the solution of which should be attempted without unreasonable prejudice or unjust discrimination so far as materials and methods are concerned. There are multitudes in every community who, though not in indigent circumstances, are unable to secure expensive services without great hardship, and other multitudes who perforce must suffer lasting harm and prolonged deformity on the same terms. Dentistry, like Medicine, is professedly a humane calling, and it would be well to consider whether the afflicted have not just claims upon the profession's resources in providing them with inexpensive means of relief. Until the time comes when the necessities of this class can be supplied with wholly unobjectionable forms of substitution at a cost that is not oppressive, or that does not altogether deny relief, it will be well to cease indiscriminate condemnation of materials and methods which, when properly considered in relation to their

yet undeveloped possibilities, are far from being unmixed evils. That there are radical and inherent objections to the use of vegetable plastics that do not attach to metallic bases is unquestionable, but it is equally true that the nature, behavior, and proper or scientific treatment of these substances have not been, until quite recently, well understood; that imperfect appliances have heretofore failed to develop their best qualities, and, above all, that there is a prevailing disregard or ignorance of all esthetic requirements in the uses to which they are applied. That the facility they afford for the ready construction of substitutes has attracted to the ranks of the profession a mercenary and unscrupulous class of operators, is as true as it is unfortunate. However powerless the profession may have been in the past to check this evil, the responsibility for its continuance in the future will rest largely with the profession itself. There is a reasonable assurance that the era of irresponsible quackery is fast passing away. The people of three-fourths of the States of the Union have, through their representatives, generously and confidingly relegated to the profession the power of providing a remedy for the evils of charlatanry, and have, under legal forms, designated our colleges and boards of examiners as the proper custodians of the profession's honor and the people's interest. A faithful execution of the trust reposed in these bodies will go far to redeem prosthetic practice from the undeserved reproach brought upon it by a prostitution of its legitimate resources wholly unworthy of toleration and utterly destructive of all sense of professional self-respect.

CHAPTER I.

FUELS EMPLOYED IN LABORATORY PROCESSES.

It is essential that the mechanical operator should have some intelligent conception of the nature and properties of such combustible substances as are ordinarily used in the dental laboratory for the generation of heat. This, and a somewhat familiar acquaintance with approved appliances used in the application of heat and adapted to his peculiar needs, are indispensable requisites to the successful practice of the department of practical dentistry to which this work relates. Only such heat-producing substances as are deemed suitable for dental laboratory operations will be considered with any degree of particularity.

The general forms of fuel may be classified as *Liquid, Solid,* and *Gaseous.* They will be treated of, in more or less detail, under these general heads.

LIQUID FUELS.

In connection with lamps designed chiefly for soldering purposes and vulcanizing, the substances usually employed are alcohol, gasolene, or kerosene. When alcohol is employed, the lamp shown in Fig. 1 is found very convenient and useful. Gasolene is used in connection with the Oxycarbon Forge (see page 43), while good kerosene, uncontaminated with naphtha, may be used with safety, and is, in many cases, a valuable substitute for other combustible materials for general heating purposes, and is largely employed in connection with vulcanite and celluloid work by those unable to command the ordinary illuminating gas.

SOLID FUELS.

Under this head are comprehended such combustible substances as are used for fires or draft furnaces, as wood, charcoal, bituminous and anthracite coal, and coke. For baking or muffle furnaces used in the construction of continuous-gum work and other allied processes, anthracite and coke are esteemed the most suitable on

account of the high temperatures attainable in their use, and the persistent or prolonged heat consequent on the comparatively slow waste of substance in the process of combustion.

Wood, except when charred, is wholly unsuited for laboratory work.

Charcoal is the solid residuum of the destructive distillation of wood. It is obtained by igniting wood, and then excluding it from the air while burning; the volatile products are thus driven off, while the carbon remains. The chemical composition of the ordinary charcoal of commerce is given in the following table, in which it will be seen to consist principally of carbon, combined with certain volatile constituents, a considerable percentage of absorbed water, and but little ash:

Carbon,	70	Nitrogen,	1
Hydrogen,	5	Ash,	2
Oxygen,	11	Hygroscopic moisture,	11

During the process of charring, the volatile constituents—hydrogen, oxygen, and nitrogen—are, in a large measure, driven off, but no temperature that can be commanded, and no time, however prolonged, will wholly expel them.

Charcoal is insipid and inodorous, is a poor conductor of heat and a good conductor of electricity, is insoluble in water, is attacked by nitric acid with difficulty, and is but little affected by the other acids or by alkalies. Its carbon constituent is exceedingly refractory to heat, and, if secluded in a retort, will neither fuse nor volatilize under the highest temperature that can be produced. This latter property of carbon, in connection with that of its comparative non-conduction of heat, makes it a valuable ingredient in the construction of supports used in soldering, represented in the carbon block and cylinder (Figs. 27, 28), and in the devices (Figs. 50, 51) combining crucible and ingot mold. Charcoal retains the organic structure of the wood from which it was produced, except when prepared at a very high temperature, when it becomes a black, shining, porous mass, resembling fossil coal, with a considerable increase in density and without a trace of organic structure.

When it is desired to maintain a high heat in a small compass, the charcoal best adapted to the purpose is that obtained from what is termed *hard* wood, as the beech, the oak, the alder, the

birch, the elm, etc. A cubic foot of charcoal derived from these woods weighs, upon an average, from 12 to 13 pounds, while a similar bulk obtained from *soft* wood, as the fir, the different kinds of pine, the larch, the linden, the willow, and the poplar, averages only from eight to nine pounds.* There is, therefore, economy in the use of the former when purchased in bulk; and of this class the beech-wood charcoal is the best on account of its greater specific gravity. Charcoals derived from the hard woods possess the additional advantage of generating a more equable and enduring temperature, and are, therefore, better adapted to operations in the laboratory requiring a prolonged heat. The more heavy charcoals require a stronger draft than those of a lighter character, as a more generous supply of oxygen is necessary to their perfect combustion. Charcoal should be kept as dry as practicable, since it readily absorbs moisture from the atmosphere, by which its calorific energy is materially impaired.

Bituminous, or **pit coals**, are generally unfit for the uses required of fuel by the dentist, on account of the excessive carbonaceous residue accompanying their combustion, and are, therefore, seldom used except when reduced to that form of mineral charcoal known as coke.

As charcoal, coke, or a mixture of the two, and anthracite coal are the heat-producing substances chiefly used in the processes of the dental laboratory requiring the employment of solid fuels, they will be more particularly described.

Coke.—This substance is a carbonaceous product obtained from bituminous coal that has been exposed to ignition for some time, excluded from the contact of air, the volatile constituents of the coal, like those of wood, having been driven off by the heat. There are two different varieties of this mineral charcoal, namely, gas coke, obtained from the retorts of gas works after the gases have been separated; and oven coke, which is made in ovens or pits, and which is considered by manufacturers as the only true coke, gas coke being merely cinder. There is a marked difference in the appearance of the two kinds of coke, the principal part of that obtained from gas houses being of a dull, iron-black color, very spongy and friable, is more rapidly consumed in the process of

* Ure.

combustion, and produces less heat than the harder and more compact variety. The best coke for heating purposes is the oven or pit coke, which has a steel-gray color, with somewhat metallic luster, is compact in structure, and splits into pieces having a longitudinal fracture. Whenever it can be procured, the latter should always be preferred in connection with the use of the baking or muffle furnaces employed in the fabrication of continuous-gum work, porcelain teeth, etc. Until the more recent substitution of anthracite, the former was exclusively employed for these purposes, and is in every way suitable in the production of high and persistent temperatures. It is sometimes used combined with charcoal, but, when fairly ignited, gives an augmented and more lasting heat when used alone.

Coke does not readily ignite, and at first generally requires the admixture of charcoal to effect its combustion; it also requires a strong draft to burn it, but when thoroughly ignited it produces an intense and persistent heat. As before stated, it is one of the principal fuels used in baking mineral teeth, porcelain blocks, and the silicious compounds employed in the construction of continuous-gum work.

Professor Piggot, in his remarks on the comparative value of fuels, observes: "Practically, for the purpose of the chemist, the best fuel is charcoal or coke, or a mixture of the two. The ash of charcoal being infusible, it passes through the bars of the grate as a white powder. Should potash, however, be in large excess, it corrodes the bricks by forming with them a silicate of potash, which runs down the walls and chokes the bars. In small quantities this action is beneficial, as it furnishes a protective varnish, and unites the bricks and lutes by forming a sort of cement, which intimately combines with them.

"Coke contains a very variable amount of ash, which is composed chiefly of oxid of iron and clay. When pure it forms a harmless slag, which injures neither the furnace nor the crucibles. Usually, however, the oxid of iron predominates. In this case the ash is very injurious, for it is reduced to a protoxid, which is not only fusible, but powerfully corrosive to all argillaceous matters, so that both the crucibles and furnaces suffer."*

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* "Dental Chemistry and Metallurgy."

Anthracite.—Anthracite is the most condensed variety of mineral coal, containing the largest proportion of carbon and the smallest quantity of volatile matter. With the exception of the diamond, it is the purest form of carbon in its natural state. The best specimens contain 95 per cent. carbon, but the average production of the purest beds of this coal will not exceed 90 per cent., and generally not more than 80 to 87 per cent. carbon. The volatile matter in the dense, hard varieties, is almost exclusively water and earthy impurities, but in common varieties the volatile portion consists of water, hydrogen, oxygen, and nitrogen, while the ash or incombustible matter contains oxid of iron, iron pyrites, silica, alumina, magnesia, lime, etc. Anthracite which contains only 80 per cent. carbon, with 20 per cent. water and incombustible matter, is the lowest grade of commercial coal, and of little value as fuel.

The general features and fractures of hard anthracite are peculiar and noticeable to the common observer. They are massive, hard, dense, amorphous or conchoidal in fracture, with fine, sharp edges when broken, and a rich satin or an iron-black sub-metallic luster. With some local exceptions the softer varieties, both red- and white-ash (by which name the Pennsylvania anthracite coals are generally known), are less massive, hard, and dense, more regular and cubical in fracture, and, exclusive of the upper red-ash beds, less rich and lustrous.

Anthracite coals, in greater or less abundance, and of varying qualities, are found in several of the States and territories of the Union, namely, in Pennsylvania, Massachusetts, Rhode Island, Virginia, Arkansas, Oregon, and in New Mexico and Sonora. Of the European anthracite fields, exclusive of those in Wales, England, the most prolific and largely developed are those in France, while others of more limited production are found in Spain, Portugal, Germany, Austria, and Norway. Anthracite also exists in Persia, India, China, and in South America. The most prominent anthracite fields of the world, however, are those of Pennsylvania and South Wales, which produce nine-tenths of the quantity used.

The first authentic account which we find of the use of anthracite in the United States was in 1768–69, when it was used by two blacksmiths from Connecticut, named Gore. It did not, on account of the difficulty of making it burn, come into use for domestic purposes till 1808, when Judge Fell succeeded in burning "stone coal"

in a grate of his own construction. This was probably the first successful use of anthracite for general purposes in the world. So imperfectly were the properties of this fuel understood, and so little known of its proper management, that four years later, Col. Shoemaker, who had disposed of several loads of it to parties in Philadelphia who were unable to burn it, was arrested, upon a writ obtained from the city authorities, as an impostor and swindler, who had sold them rocks for coal.

Prof. H. D. Rogers explains the formation of anthracite by supposing it to be the result of altered bituminous coal metamorphosed by intense heat, and, of course, by heat induced subsequent to the formation of the bituminous beds; and he further explains the escape of the volatile portion of the latter as gas through cracks and openings caused by the plication of the anthracite strata. This plication follows closely the general type of the paleozoic rocks, which are intensely crushed and folded near the contact of their edges with the igneous or granitic rocks, and much less plicated and distorted in a western direction. This theory, though natural and ingenious, is controverted by others who contend that anthracite is not a metamorphosis of bituminous coal, but as much a normal creation as the bituminous variety itself, from a combination of its constituents under superior heat, however the original elements were produced.

The particular mineral fuel under consideration has been treated of here somewhat at length, for the reason that it is being more generally employed of late years by the dentist, not only for refining and general heating purposes, but more especially in those important processes of the dental laboratory in which more or less refractory silicious substances requiring a high, uniform, and prolonged heat, are employed in compounding body and gum enamels, in baking mineral teeth, and in the construction of continuous-gum work. For the latter especially, it is preferred by many to coke, in connection with solid fuel furnaces.

Owing to the difficulty of igniting anthracite, it is customary to mix with it at first about an equal quantity of charcoal. Its proper combustion after ignition, when burned alone, requires a strong draft, which is ordinarily attainable in use of the ordinary draft or muffle furnace properly connected with a suitable flue. Under conditions that insure more or less complete combustion, the chief of

which is a generous supply of oxygen, anthracite will yield a higher temperature than any other kind of solid fuel. The blast furnace is, therefore, best adapted to this end, though for all ordinary purposes requiring heat in the dental laboratory the ordinary chimney draft will be sufficient. To recapitulate somewhat, it may be said, not only in reference to anthracite, but to the other solid fuels mentioned, that in order that the greatest amount of heat may be generated, it is necessary that the conditions essential to their most perfect combustion should be strictly observed; these, as before stated, have reference mainly to an unobstructed circulation of air in order that oxygen may be freely supplied to them. To this end the furnace should be kept clean, the bars of the grate unbroken, and a good draft obtained. The condition in which the fuel is applied will also modify the results. Thus, for example, if the lumps are too large, they will absorb heat, and caloric will be lost; if too small, they will be too rapidly consumed. It is essential, also, to have the fuel as free as possible from dust and dirt, as these fine particles in any considerable quantities obstruct the draft, and prevent a thorough ignition of the mass. Coke, especially, should be preserved clean, and should be broken into fragments not larger than an inch or an inch and a half in diameter, and, as nearly as possible, in the form of blocks or cubes, as these leave more open spaces for the free circulation of air.

GASEOUS FUEL.

Illuminating Gas.—The ordinary illuminating gas, derived from the destructive distillation of bituminous coals, is a form of fuel that, of late years, has largely supplanted the use of the liquid and solid varieties for heating purposes in the dental laboratory. The introduction of gas, for the uses indicated, marks an era in prosthetic practice, so far as the application of heat for metallurgic purposes is concerned, in which inventive genius has been industriously and successively employed in devising and perfecting appliances designed to obviate entirely the necessity of employing other forms of fuel heretofore used, and which are, in many respects, inconvenient and objectionable. So fruitful have been these later devices in meeting the necessities of the dental metallurgist, and so reasonably certain is it that more extended experiments in the construction of furnaces adapted to this mode of producing

heat will, in the near future, meet all the requirements of ceramic art, as applied to dental prosthetics, that it may be confidently predicted that all solid fuels for these purposes will be wholly banished from the laboratory wherever gas can be commanded for the generation of heat. The latter, intermixed with atmospheric air in proper proportions, and used in connection with burners and furnaces of suitable construction, is, in all essential respects, preferable, since it is comparatively free from dirt and smoke, and is capable of producing a rapid, equable, and intense heat, which is completely under the control of the operator as respects duration and the degree of temperature required for any given operation.

Natural gas has, until recently, been obtained only in very limited quantities. There are many localities where combustible gases have long been known to issue from the earth. Gas has been used in China for centuries, conveyed in bamboo tubes from fissures in salt mines, in excavations from 1200 to 1600 feet in depth. Near the Caspian Sea, in Asia, there are several so-called eternal fires caused by gas issuing from the soil. In parts of New York it issues from bituminous limestone interspersed among the slates and sandstones of the Portage group; but the most prolific sources of natural gas are in the coal regions of western Pennsylvania, where great wells are yielding almost unlimited supplies of this light- and heat-producing combustible, and which, in some of the larger cities, is being utilized not only for illuminating purposes, but for fuel in many of the manufacturing establishments.

The chief supplies of illuminating gas, however, are derived from the destructive distillation of various grades of bituminous coal, and, to a more limited extent, from wood, peat, resin, petroleum, oils and fats, and from water and coke. As the gas used in the dental laboratory for the generation of heat is the common house illuminating gas obtained from coal, this variety only will be treated of in this place.

Bituminous coals, such as English cannel and boghead coals, Ohio cannel, and the coking coals of Pennsylvania, Maryland, and Virginia, are commonly used in the manufacture of illuminating gas. When bituminous coal is heated to redness in the presence of air, it is principally converted into gases which unite with oxygen; but if air is excluded, as when the coal is confined in retorts, the gaseous products, unable to unite with oxygen, may be col-

lected in receivers and burned in tubes. The products of the destructive distillation of bituminous coal consist of a great number of gases, liquids, and solids, which may be conveniently included under the following heads, according to an analysis by Bunsen:

Coke,	68.93	Olefiant gas,	0.78
Tar,	12.23	Sulphuretted hydrogen,	0.75
Water,	7.40	Hydrogen,	0.50
Marsh gas,	7.04	Ammonia,	0.17
Carbonic oxid,	1.13	Nitrogen,	0.03
Carbonic acid,	1.07		

The illuminating power of the gas may be regarded as depending principally upon the amount of olefiant gas (heavy carburetted hydrogen) which it contains, the bulk of other gases being carriers rather than light-producers. The olefiant gas is separated by ignition into marsh gas (light carburetted hydrogen) and carbon, the solid particles of which become incandescent and emit white light, which is observed in the luminous cone of a gas flame, and which has the same constitution as that of a candle. The luminosity of a gas flame depends both upon the percentage of heavy hydrocarbons it contains and the amount of atmospheric air or oxygen mixed with it. With the admixture of air or oxygen, the illuminating power of the gas is diminished, while there is at the same time increased evolution of heat. This fact is of interest and value to the dentist, since it underlies the construction of all the modern forms of heating appliances made on the principle of the Bunsen burner, which provides for intermingling currents of atmospheric air and gas. Oxygen thus applied to the gas jet, and combining with the carbon at the moment of ignition, greatly augments the heat of the flame, while the latter becomes almost non-luminous.

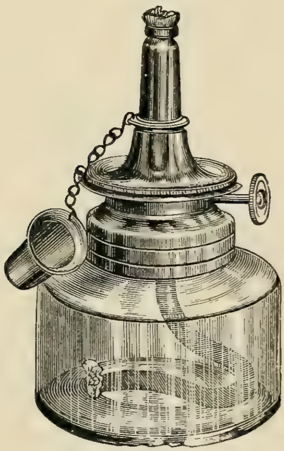
Oxyhydrogen Gas.—A combination of nitrous oxid and illuminating gas has been used of late in the dental laboratory with highly satisfactory results, forming practically an oxyhydrogen flame of great heating power. (See Dr. Knapp's oxyhydrogen blowpipe, page 44.)

CHAPTER II.

APPLIANCES USED IN THE GENERATION AND APPLICATION OF HEAT; WITH SOME OBSERVATIONS ON SOLDERING.

The modes of generating heat, and the appliances used in its application to the various mechanical processes of the dental laboratory, will require more or less detailed descriptions of the several agencies employed for these purposes. These relate to *Lamps, Burners, Blowpipes, Supports, Crucibles,* and *Furnaces.* As full a description of these several appliances will be given as is compati-

FIG. 1.



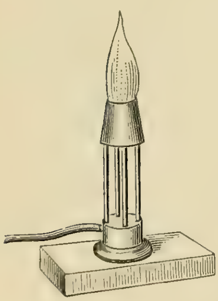
ble with the scope of the present work. The agencies employed in the generation and application of heat alluded to under the head of lamps, burners, supports, and blowpipes, are such as are used chiefly in soldering, one of the most important and not always the least difficult processes of the dental laboratory, while furnaces are largely used for melting and refining purposes, compounding body and gum materials, baking porcelain teeth, and in constructing continuous-gum work. Heaters are adapted to a variety of pur-

poses requiring moderate temperatures, as melting some of the more fusible metals, warming water, heating plaster molds preparatory to packing plastic substances, etc.

Lamps.—For all the minor operations of the laboratory requiring the application of moderate degrees of heat in the use of either the mouth or the simpler forms of bellows blowpipe, an ordinary alcohol lamp or the gasolene furnace described on page 55 will be found serviceable and efficient. When, however, gas can be commanded, it is preferable to the oils or alcohol for heat-producing purposes, on account of its greater convenience and freedom from accident.

Burners.—The ordinary gas flame is unsuitable for soldering or other operations, by reason of the carbonaceous residue with which it is constantly charged. This source of uncleanliness may be gotten rid of by an admixture of air with the gas flame. This intermingling of gas and air currents for the purpose of augmenting the heat of the gas flame, and of rendering it in other respects more suitable for general metallurgic purposes, was first practised by Bunsen, a distinguished German chemist, by means of a simple contrivance represented in Fig. 2. All modern heat-producing appliances usually denominated Bunsen burners utilize the same principle in the generation of heat, and differ only in mechanical construction from Bunsen's original device.

Fig. 2.



A very simple contrivance embracing the principle of the Bunsen burner, is shown in Fig. 3. The gas is supplied through a flexible rubber tube connected with the stem of the burner, and connected at the other end with any ordinary gas burner conveniently located in the laboratory. For soldering small pieces, and for many other purposes requiring a ready and manageable heat, the writer has used this simple appliance, with great satisfaction. It is especially useful in "waxing up" a base plate, heating water, vulcanizing, and other minor operations requiring a moderate and easily-graduated heat.

To obtain a flame of greater volume than is possible with the burner just described, one such as shown in Fig. 4 is employed.

This contrivance is especially adapted to drying and heating up large pieces before soldering, and for melting metals in considerable quantities.

Another heating apparatus of recent introduction, designed, in

FIG. 3.

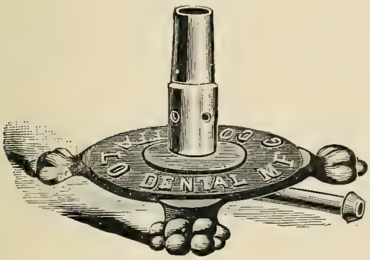
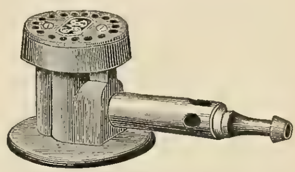
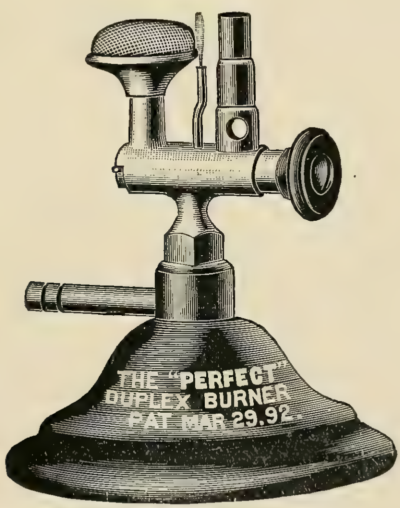


FIG. 4.



part, for soldering with the use of blowpipes, is represented in Fig. 5. It is called the "Perfect Duplex Burner," and will be found very convenient for laboratory use. It is an important ad-

FIG. 5.



vance beyond the well-known revolving form of duplex burner. Both burners are fixed, and a small jet is placed between them, the gas flow being governed by a knob, a quarter turn of which to the right or left ignites either burner when once the small jet is

lighted. The plug has a long bearing, and is carefully ground in so as to eliminate wear as far as possible. The knob is not affected by the heating up of either burner. The apparatus is well made, with every observed defect of the old form eliminated and every shortcoming remedied. The old form was good; the new is better, and comes very close to fulfilling the intention of the inventor—to supply the need of metal-workers for a perfect self-lighting soldering and Bunsen burner combined.

BLOWPIPES.

Following the description of lamps and burners given in the preceding pages, it would seem appropriate to consider next the various forms of blowpipes used in the application of the heat produced by means of the appliances named.

Various modifications in the form of the blowpipe have been introduced from time to time, and are named according to the means used to produce the blast, as—*mouth, bellows, self-acting,* or *spirit,* and the Gasolene or "Oxycarbon" blowpipe.

In addition to the varieties mentioned, there are others, used in producing extreme degrees of heat, as the "oxygen blowpipe," with which the flame is blown with a jet of oxygen; and another, with which the two gases, oxygen and hydrogen, are burned, called the "oxyhydrogen blowpipe." The latter is capable of producing a heat that immediately fuses the most refractory substances, as quartz, flint, rock-crystal, plumbago, etc. With it gold is volatilized and iron rapidly consumed when placed in the flame; while platinum, next to iridium the most infusible of all known metals, has been melted in quantities exceeding 100 ounces by means of this powerful instrument. As, however, these blowpipes are, for the most part, of no special practical utility in the dental laboratory, reference will be had only to the one recently introduced by Dr. Knapp, of New Orleans, La. Nor is it deemed necessary to embrace descriptions of spirit blowpipes, as they have fallen, of late years, almost wholly into disuse.

MOUTH BLOWPIPE.

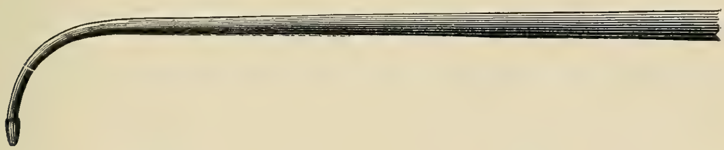
This instrument has been long in use, is simple in its form and construction, and, for general use in the application of moderate degrees of heat, is both convenient and economical. Those

accustomed to its use are enabled to produce a continuous blast of considerable force, and soon acquire the facility of regulating the heat produced with equal if not greater precision than can be readily attained in any other way.

The most simple form of the mouth blowpipe is shown in Fig. 6. It consists, usually, of a plain tube of brass, larger at the end applied to the mouth, and tapering gradually to a point at its other extremity, the latter being curved and tipped at the point with a conical-shaped, raised margin, to protect it from the action of the flame; the caliber of the instrument terminates here in a very small orifice. The point of the instrument, as well as that part of it received into the mouth, is sometimes plated with a less oxidizable metal than brass, as silver or platinum. The stem is generally from 12 to 20 inches in length, and the mouth extremity from ½ to ¾ of an inch in diameter.

In operations requiring protracted blowing, a somewhat different form of the instrument will be required, owing to the accu-

FIG. 6.

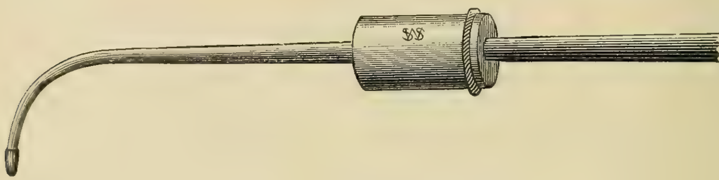


mulation of moisture within the tube, which, being forcibly expelled from the orifice, spurts upon whatever is being heated and interrupts the blast; also, on account of the fatigue, which in process of time renders the muscles of the mouth and face engaged in the act to a great extent powerless.

The difficulties mentioned may be obviated, in a great measure, by applying the form of blowpipe represented in Fig. 7. To the mouth extremity is attached a circular concave flange or collar which receives and supports the lips. To the shaft, near its curved extremity, is adjusted either a spheric or cylindric chamber which collects and retains the moisture as it forms within the pipe. By allowing that part of the tube connected with the curved end to pass part way into the chamber, a basin is formed at the depending portion of the latter, which, by collecting the fluids, will effectually prevent them from overflowing and passing into the tube beyond.

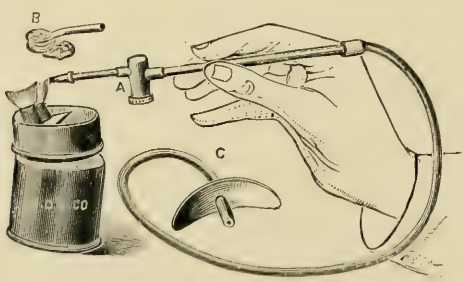
Another form of mouth blowpipe is exhibited in Fig. 8. It will be seen to be wholly unlike any mouth blowpipe yet devised, and admits of great latitude of movements in the application of heat. This form of the mouthpiece is especially adapted to continued blowing without strain on the lips, while the opening is well under the control of the tongue. The blowpipe proper is held as a pencil, the chamber collecting condensed moisture and preventing the passage of heat up to the end. The instrument can be readily changed from a cold- to a hot-blast blowpipe by substituting the coil (B) for the plain jet or tip.

FIG. 7.



There are other allied forms of the mouth blowpipe, but as they are constructed more especially for chemical examinations or analyses, and as they possess no advantages for dental purposes, over those already mentioned, a description of them is not necessary.

FIG. 8.



Mechanism Involved in the Act of Producing a Continuous Blast with the Mouth Blowpipe.—As a steady, continuous current of air from the blowpipe is preferable to the interrupted jet in all those operations where it is desired to produce a steadily augmenting heat, the following remarks explanatory of the method of producing it are subjoined, in the belief that they will render easier a process not always readily acquired.

"The tongue must be applied to the roof of the mouth, so as to interrupt the communication between the passage of the nostrils and the mouth. The operator now fills his mouth with air, which is to be passed through the pipe by compressing the muscles of the cheeks, while he breathes through the nostrils and uses the palate as a valve. When the mouth becomes nearly empty, it is replenished by the lungs in an instant, while the tongue is momentarily withdrawn from the roof of the mouth. The stream of air can be continued for a long time without the least fatigue or injury to the lungs.

"The easier way for the student to accustom himself to the use of the blowpipe, is first to learn to fill the mouth with air, and while the lips are kept firmly closed to breathe freely through the nostrils. Having effected this much, he may introduce the mouthpiece of the blowpipe between his lips. By inflating the cheeks and breathing through the nostrils, he will soon learn to use the instrument without the least fatigue. The air is forced through the tube, against the flame, by the action of the muscles of the cheeks, while he continues to breathe, without interruption, through the nostrils. Having become acquainted with this process, it only requires some practice to produce a steady jet of flame. A defect in the nature of the combustible used, as bad oil, such as fish oil, or oil thickened by long standing or by dirt, dirty cotton wick, or an untrimmed one, or a dirty wick-holder, or a want of steadiness of the hand that holds the blowpipe, will prevent a steady jet of flame. But, frequently, the fault lies in the orifice of the jet, as too small a hole or its partial stoppage by dirt, which will prevent a steady jet of air and lead to difficulty. With a good blowpipe, the air projects the entire flame, forming a horizontal, blue cone of flame, which converges to a point at about an inch from the wick, with a larger, longer, and more luminous flame enveloping it, and terminating at a point beyond that of the blue flame." *

BELLOWS BLOWPIPE.

There are many processes of the dental laboratory requiring the application of a higher temperature than is obtainable with the mouth blowpipe. A more powerful and persistent air-blast is

* "The Practical Use of the Blowpipe."—*Anon.*

readily produced by a bellows or foot-blower, used commonly in connection with a burner of suitable form attached to the common gas-jet, by means of which the gas is furnished with the oxygen required for its combustion in a state of intimate mixture.

A simple and compact form of bellows or foot-blower is shown in Fig. 9. The pressure obtainable with this instrument is continuous, equable, and completely under the control of the operator, but the current may be greatly increased in power after the rubber disk is distended until forced against the net.

A bellows of similar construction, but with the position of the blower reversed, is shown in Fig. 10. By this arrangement the disk is less liable to injury, while it prevents the valve from picking up dirt from the floor.

Fig. 9.

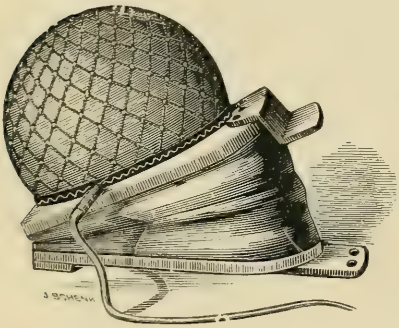
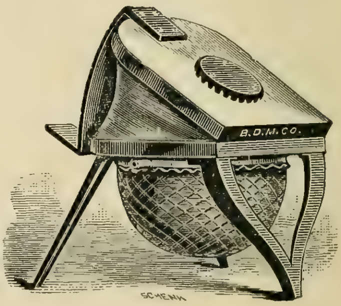


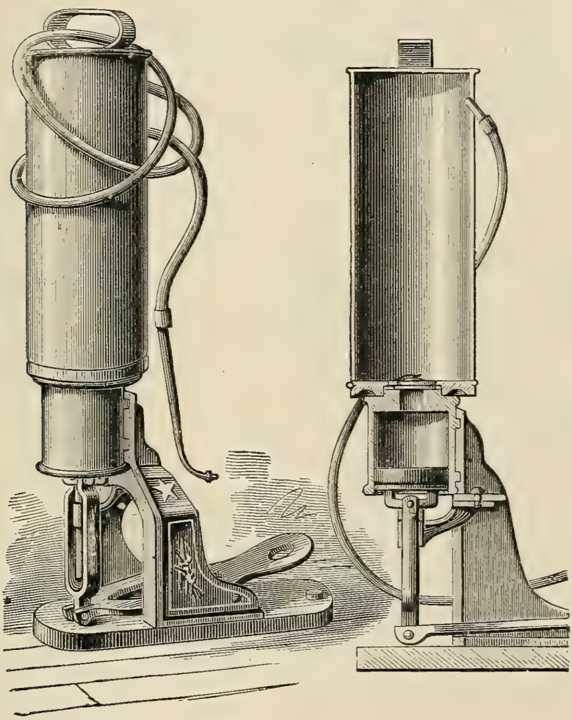
Fig. 10.



A contrivance essentially different in its construction from the ordinary bellows employed to produce the air-jet is shown in Fig. 11, and is known as the "Burgess Mechanical Blowpipe." When in use, the air is drawn into a cylinder and condensed in an air-chamber, ready to be used in large or small quantities at the will of the operator, by a rapid or slow movement of the treadle. A pressure of from 2 to 12 pounds is produced at the will of the operator, by accelerating the motion of the foot, and can be continued with but little exertion. The machine weighs 12 pounds, and measures 22 inches in height. The pump-cylinder is 2½ inches in diameter, with three-inch stroke. The internal mechanism is clearly illustrated in Fig. 11, and its simplicity will be at once appreciated. It requires an occasional drop of oil upon

the leather packing-ring, and this, with ordinary care, will make the apparatus last for years. When operating, place the entire foot upon the treadle, so that an easy rocking motion is obtained; by pressing the toe downward, air is drawn into the cylinder, and in reversing the motion it is driven into the air-chamber above. The pipe-outlet is much smaller than in the mouth blowpipe, to

FIG. 11.



enable a pressure to be obtained, which is increased or diminished by a quick or slow motion of the treadle. The air-chamber is easily filled, and when so a constant supply of pure air is at the control of the operator.

The blowpipes used in connection with the bellows are of various forms. Fig. 12 represents one form of apparatus employed in the application of the air-blast to the gas-flame.

A movable gas-jet attached to two short arms of an ordinary

gas-pipe is made to receive within it the blowpipe point connected with the rubber tube, the air-tube terminating a little within the open mouth of the gas-jet; it is thus a tube within a tube, with a space between them for the admission and passage of gas. The gas, being admitted by turning the tap connected with the gas-pipe, is ignited, when the current of air from the bellows will strike the center of the flame and project it upon whatever is to be heated. The connected portions of the air- and gas-jets are so attached to the main pipe as to admit of an upward and downward motion, while the volume of gas and air is readily graduated by the stop-cocks attached to the air- and gas-tubes.

A bellows blowpipe, constructed on similar principles, but

FIG. 12.

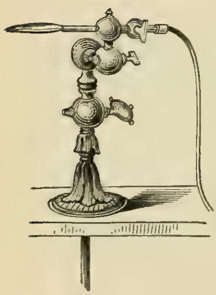


FIG. 13.

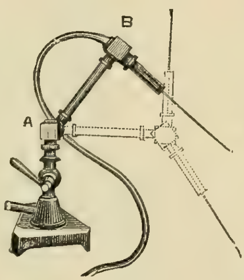
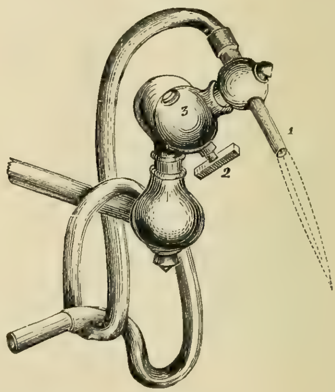


FIG. 14.



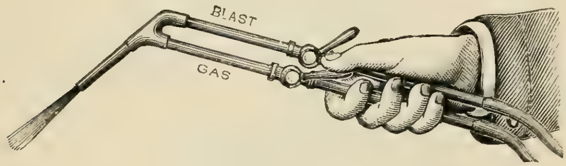
admitting of greater latitude of movements, is exhibited in Fig. 13. As will be readily observed, it is capable of being adjusted in any desired position. The jet-tube may be raised or lowered to any height and turned in any direction. A touch will direct the flame on any point while the blowpipe stands in the same position on the table; there being no necessity for raising, lowering, or adjusting work before it.

Macomber's gas blowpipe, Fig. 14, differs somewhat in construction from the latter, its capability of adjustment being regulated by a ball-and-socket attachment which imparts to it, at the will of the operator, a latitude of movement or adjustment of the blowpipe point that is practically without limit. The direction of the point, 1, is regulated by the joint, 3, and the supply of gas controlled by

the stop-cock, 2. The air is supplied by the bellows through the flexible tube.

A very convenient, manageable, and effective instrument for many purposes requiring the application of heat in the dental laboratory is the hand blowpipe shown in Fig. 15. It is capable of producing very high degrees of heat, but the intensity of the

FIG. 15.



latter may be graduated at the will of the operator, as the stop-cocks, which are both under perfect control of the thumb of the hand which holds the blowpipe, regulate the supply of gas, and control the volume of air. The air-jet is ⅛ of an inch bore, and requires a supply from a bellows.

FIG. 16.

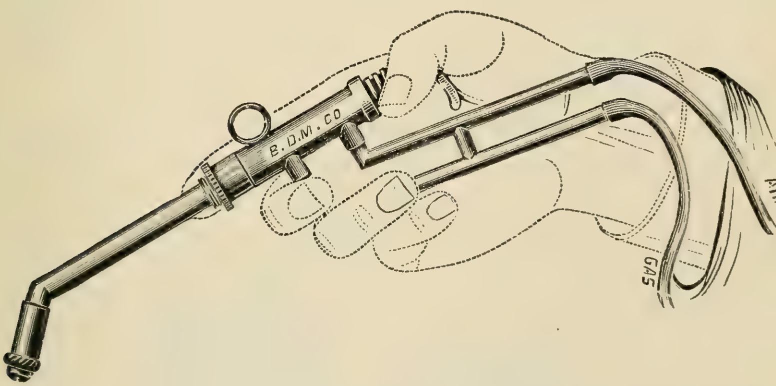


Fig. 16 represents an improved pattern of the Fletcher Automaton, designed especially for crown- and bridge-work. It is made of smaller tubing than the No. 6 A or B Automaton, the end being bent at an angle to give greater facility in directing the flame. The adjustable nozzle is screwed on and off, instead of operating by a slip-joint, as in other patterns of the automaton

blowpipe. Its length is increased, removing the hand further from the heat. The supply of gas and air is controlled by a longitudinal movement of the tube, instead of a rotative one. A spring opposes the movement of the hand, and a slight variation of pressure upon the end-piece, when it is held as shown, is sufficient to give either a pointed jet or a full-sized brush flame at pleasure. An improved tip is used on the air-jet, and the small blue-pointed reducing flame is very easily and perfectly produced.

The gas passage does not close entirely, but allows the passage of enough gas to prevent the flame from going out when the blowpipe is not in use. It can be hung up by the ring shown on its body, when it is desirable to get it out of the hand.

The several forms of bellows blowpipe illustrated in these pages are complete and efficient, and admirably adapted to the necessities of the mechanical operator. In most instances, the jet may be elevated or depressed at will, while the force of the air-current and the volume of the gas-flame can as readily be increased or diminished. The operator is thus enabled, with the greatest ease, to produce a heat adapted to the most delicate operations, or to instantly change it to a heat so intense that pure gold in considerable quantities is almost immediately fused in the flame. They are, therefore, well adapted to all operations in the dental laboratory.

THE GASOLENE OR OXYCARBON BLOWPIPE.

Where illuminating gas is not available, the oxycarbon forge or blowpipe will be found most useful. It gives a high, steady, smokeless, and nearly odorless blast, and at the same time does not require either the bellows attachment or lung power. It is less expensive than gas or alcohol, is safe, portable, durable, and is simple to control and handle. It can be changed instantly from an intense heat to a feeble flame, or the reverse. The entire forge is only about 12 inches high, having a base 9 inches in diameter, and can be run all day with ½ gallon of 74° deodorized gasolene (see page 55) without any attention, excepting a few minutes' use with the rubber bulb to keep up the necessary air pressure. This forge is illustrated in Figs. 17, 18, and 19.

It can be used for vulcanizing, heating investments, soldering, melting metals, annealing plates, for waxing, or any purpose for which heat may be required in the laboratory.

Fig. 17.

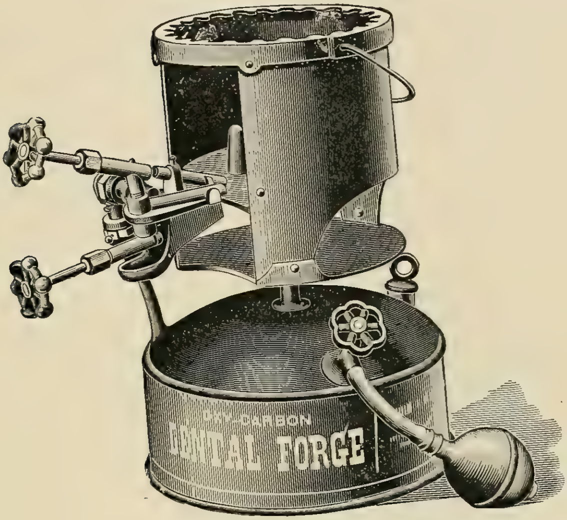
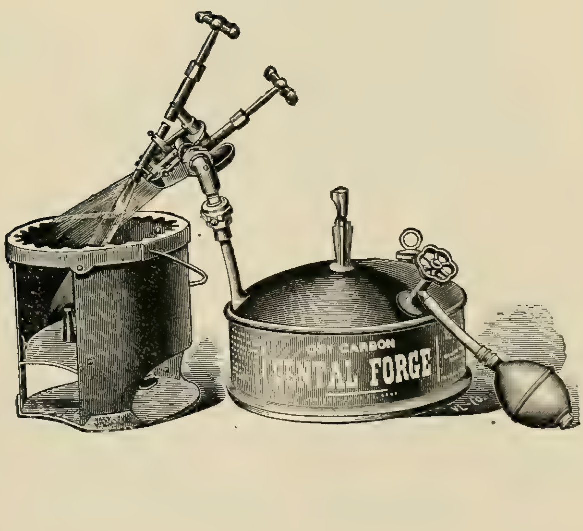


Fig. 18.



OXYHYDROGEN BLOWPIPE.

No dental laboratory appliance for heating purposes has ever been devised that has attracted so much attention, or elicited such cordial and unreserved praise by expert manipulators, as that invented by Dr. J. Rollo Knapp, of New Orleans, La., and shown in Fig. 20.

It is described as being to all intents and purposes an oxyhydrogen blowpipe divested of the cumbersome paraphernalia usually accompanying the latter, and reduced to a practical size

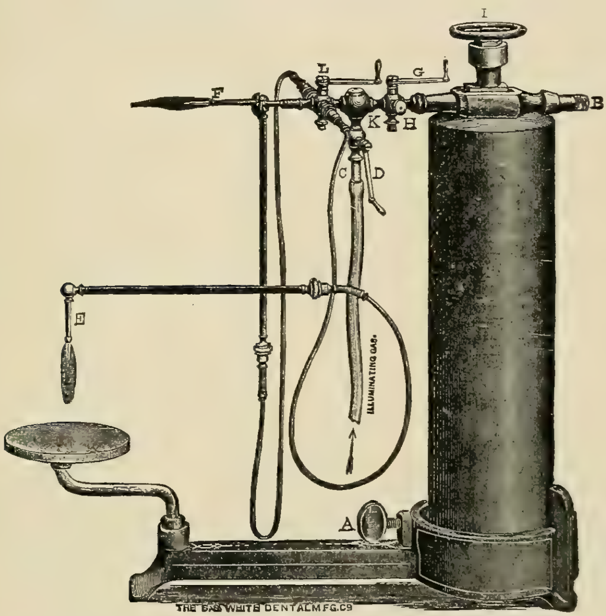
FIG. 19.

and shape for soldering operations. It is essentially an apparatus for securing the consumption of hydrogen in a highly oxygenated atmosphere, the resulting flame being second in intensity only to that of the oxyhydrogen blowpipe proper. It will melt gold or its alloys in quantities suited to its capacity almost instantly, without other exertion on the part of the operator than the adjustment of a couple of small levers. It is economical of time and materials, and not the least notable of its good qualities is its cleanliness. Its inventor has been accustomed to do all his soldering of crown- and bridge-work without leaving the operating room. It can be used wherever illuminating gas is available. Any of the soldering

operations of the laboratory, from the largest piece of bridge-work to the most delicate joining of the narrowest bands or finest wires, are accomplished with equal facility. With illuminating gas of good quality and sufficient pressure, a pennyweight of 20-carat gold can be melted in thirty seconds. When the investment is large, it must first be heated by other means.

The apparatus consists of the blowpipe attachments, connected to the yoke of a nitrous oxid gas-cylinder, the cylinder being set upright, and secured by a thumb-screw on one end of an iron base

FIG. 20.



or stand, at the other end of which is pivoted a table, upon which to rest the work. The blowpipe proper is a continuation of the outlet tube of the gas-cylinder. A lever-valve, G, regulates the supply of nitrous oxid. Just beyond this valve is the mixing chamber K, to which the illuminating gas is conducted from the gas-bracket by means of rubber tubing, entering the bottom of the chamber through the valved tube, C. The lever, D, controls the supply. The mixing chamber is provided with a gauze screen to prevent the flame from being drawn into the supply tubes. Imme-

diately beyond the mixing chamber the pipe is branched to afford two flames of different sizes, E and F, which can be used independently of each other or both together. The valve-lever, L, regulates the flame in both. For greater convenience in manipulation the pipe-nozzles are connected with the branched pipe by rubber tubing. From the body of the valve L an arm extends, at the end of which is a small scalloped disc as a holder for the flame-nozzles when not in use. In the illustration one of the nozzles is shown in the holder, the other being directed to the revolving table.

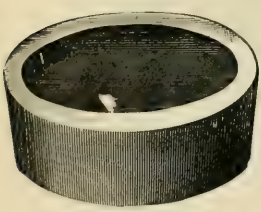
SUPPORTS.

There are many processes in the dental laboratory for which it is necessary to provide a suitable holder or support, as in melting small quantities of gold and silver, and in all the varied operations requiring the use of solder.

For melting or soldering small pieces, a variety of simple devices, easily and economically constructed, may be used, among which are the following:

Charcoal, either alone or combined with other non-conducting substances, is very commonly employed, and being combustible, adds materially to the heat of the blowpipe-flame. A convenient support of this kind may be made by selecting a fair-sized block of compact, close-grained charcoal, derived from some of the hard woods, such as oak or beech, and investing it in plaster ½ or ¾ of an inch thick, one end or side being left open and made concave, to receive whatever is being heated. Or a plaster cup, two or three inches deep and three or four inches in diameter, may be used, its interior being filled with a mixture of plaster, sand, asbestos, and pulverized charcoal. Coke, encased in the same manner as charcoal, may be substituted for the latter, and has the merit of being more lasting, but in all other respects is inferior for the purpose. Supports for the uses under consideration are also sometimes made of pumice-stone.

Fig. 21.

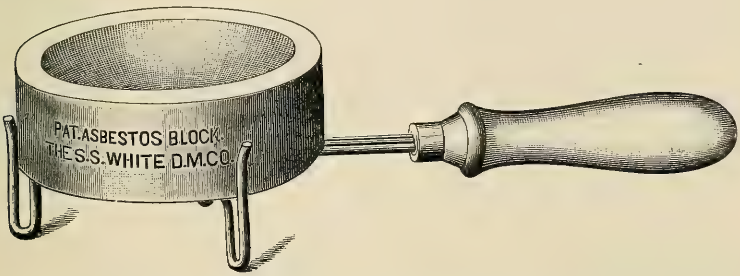


Manufactured supports, composed of asbestos and carbon, very convenient and durable, may be obtained at the dental depots. Fig. 21 represents a carbon block designed for melting and solder-

ing, while Fig. 22 shows an asbestos block manufactured for the same purpose.

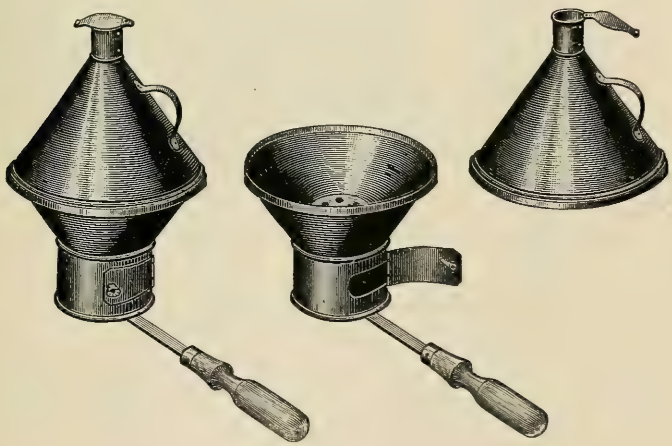
For soldering purposes exclusively, especially in uniting teeth to a metallic base, either of the following means of support for the

FIG. 22.



invested piece will be suitable: A simple holder, which the operator himself can easily construct, may be made of a circular or semi-elliptic piece of heavy sheet iron, the margin of which is serrated and turned at right angles, forming a cup. To the under side and center of this an iron rod, 10 or 12 inches long, may be

FIG. 23.

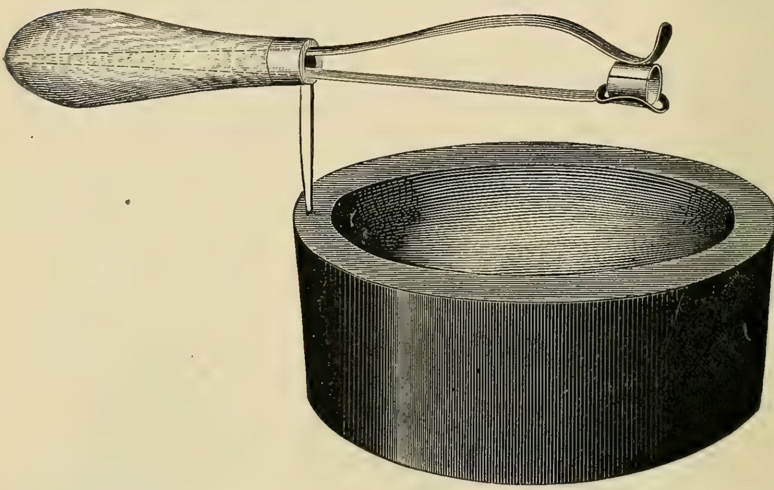


permanently riveted, or it may be made to revolve on the handle, so that the heat may be thrown directly upon any particular part of the piece to be soldered without disturbing the latter.

A small *hand furnace* (Fig. 23) is sometimes used, and will be

found a very convenient and useful apparatus, not only for soldering, but for preparatory heating. It consists of a funnel-shaped receptacle made of sheet iron, with a light grate or perforated plate of the same material adjusted near the bottom, and an opening on one side, underneath the grate, for the admission of air. The upper part of the holder is surmounted by a cone-shaped top, which may be readily removed by a handle attached to it, while to the bottom of the furnace is attached an iron rod, five or six inches long and terminating in a wooden handle. The piece to be soldered is placed inside on a bed of charcoal, the top adjusted to its place, and the fuel ignited; when the case is sufficiently

Fig. 24.



heated, the top may be lifted off, and the piece remaining in the furnace soldered with the blowpipe in the usual manner, the furnace thus serving the purpose of a holder.

The Melotte Clamp or Support.—A very simple and convenient clamp or support, devised by Dr. George W. Melotte, of Ithaca, N. Y., is shown in Fig. 24 and is especially designed for crown- and bridge-work.

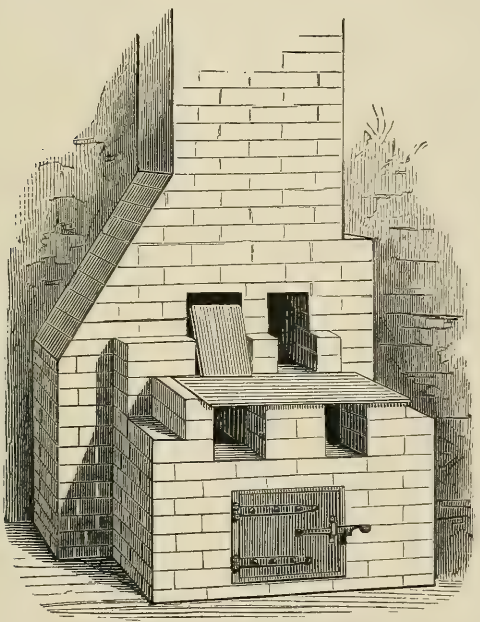
It is the design of this invention to provide means for holding gold crown collars and their caps so that without change of size or shape their closed joints can be neatly soldered. Fig. 24 exhibits a collar thus held. A slight pressure suffices, and this is

effected by pushing the jaw shank into the handle, which by its spur is then fixed in a piece of charcoal or on the bench; the jaws turn in the handle to bring the joint into position, when the left hand is set free to manipulate the solder while the blowpipe is directed by the right hand as usual.

FURNACES.

It would be inconsistent with the design of the present work to introduce a description of any form of furnace other than those of practical use to the dentist. Many of those used in the arts, or

FIG. 25.

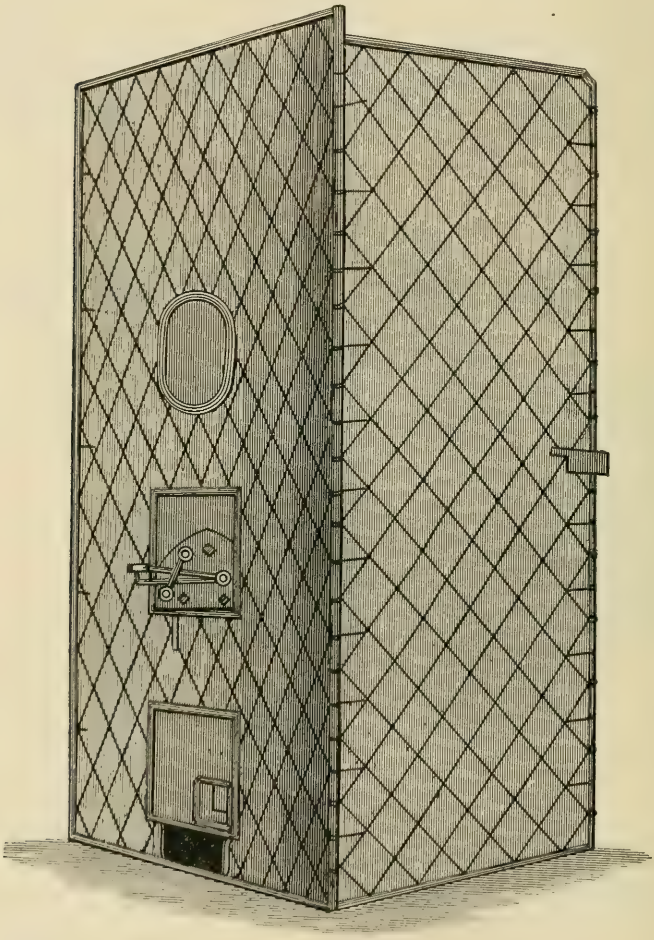


for chemical and pharmaceutical purposes, embrace almost endless varieties, and have no special adaptation to the uses required of them in the dental laboratory.

Draft or Wind Furnace.—A very convenient, portable, and economical furnace may be made of sheet iron, of any desired shape or dimensions, though usually of small size and cylindric in form. A light grate, or heavy piece of sheet iron, perforated with holes, to admit of the passage of air, should be adjusted near

the bottom, while above and below the grate are two openings, the lower one communicating with the ash-pit, and the upper one for the introduction of fuel and substances to be heated. By surmounting this simple apparatus with a pipe, or connecting it with

FIG. 26.



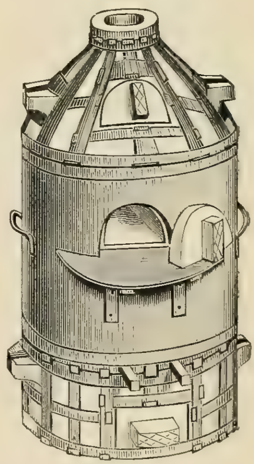
the flue of a chimney, it will be found efficient in many of the minor operations of the shop, as melting metals, heating pieces preparatory to soldering, annealing, etc.

A more durable and serviceable draft-furnace, however, may be

built of masonry, a convenient form of which is represented in Fig. 25. The construction of this stationary fixture is so plainly exhibited in the cut that any extended description of it seems unnecessary. The upper holes represent the entrance to the fire chambers, which are distinct from each other; the lower ones communicate with the ash-pit, which is common to both chambers. Two fire apartments are here shown, one for melting and refining the more precious metals, heating up for soldering, etc., the other being used exclusively for fusing the baser metals, as zinc, antimony, lead, etc. These furnaces are sometimes constructed with a single fire-chamber, but the one exhibited is in every way preferable.

Baking Furnace.—The chief purposes to which these furnaces are applied are the manufacture of porcelain teeth, single and in sectional blocks, the preparation of silicious compounds, and the construction of what is known as "continuous-gum work." An excellent form of furnace is shown in Fig. 26, which is made after the description of Dr. L. P. Haskell, who says of it: "If you wish to shut the heat out of the room, have a wire frame made, over sides and top, and sitting against the chimney with a movable front, and holes corresponding with the furnace openings, and cover with asbestos felt." This is shown complete in the illustration.

Fig. 27.



A furnace especially designed and introduced for continuous-gum work, is exhibited in Fig. 27. The fire-pit below the muffle is of more than usual capacity, insuring, it is claimed, perfect results at each baking. The part which is subjected to the greatest heat is free from angles and incased with sheet iron, rendering it less liable to crack from long use. The fire or ashes may be withdrawn by removing the two projecting grate-bars. It is 24 inches high and 12¼ inches in diameter.

As the purposes, heretofore stated, for which these several furnaces are designed require a steady, intense, and persistent heat, the fuels commonly used, as fulfilling most perfectly these indi-

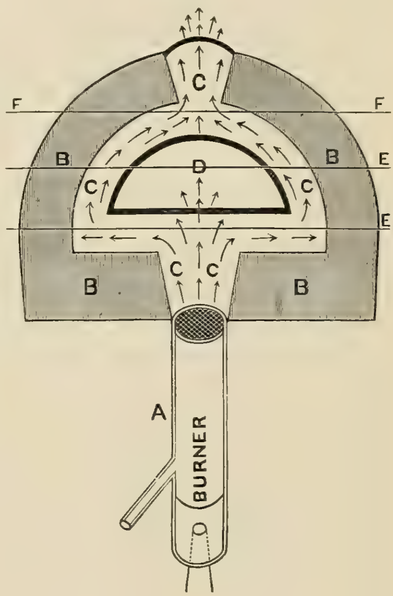
cations, are coke, or a mixture of charcoal and coke, and anthracite, preference being given, by many, to the latter.

It will be observed that, in connection with the several kinds of furnaces heretofore mentioned, heat is generated by the use of solid fuels. Within the past few years, baking- or muffle-furnaces have been constructed with reference to their special adaptability to the use of gas in combination with the air-blast. While these later devices commend themselves on the score of their greater convenience and economy of time in firing, and their freedom from the dirt and smoke attending the use of solid fuels, their successful application to the special uses for which they are mainly designed, has been attended with difficulties which have heretofore been adverse to their general adoption by the profession, and which it has been the aim of inventors to overcome. This has been measurably accomplished, and the successes so far attained give fair promise of a complete revolution in the modes of applying heat in all operations concerned in the fabrication of the various forms of dental porcelain. The chief obstacle to the successful use of gas in connection with the air-blast in the processes relating to the manufacture of porcelain teeth, gum-enamels, continuous-gum work, etc., is in the increased liability to so-called "gasing," or the formation of bubbles, due to absorption and elimination of gas that finds its way into the muffle during the process of baking. The manner in which this accident occurs is thus accounted for in a communication to the author from Dr. C. H. Land, of Detroit, Michigan. Alluding to the kind of furnaces under consideration, the writer says:

"To be able to fuse the body and enamel of which artificial teeth are composed in an easy and convenient manner is a thing the profession has studiously sought after, realizing that, when properly accomplished, the means to elevate prosthetic dentistry from an ordinary mechanical enterprise to one of true art, would be at hand. The mere construction of a furnace after the usual modes has been simple enough, and the question of securing the necessary degree of heat was long ago accomplished. However, the ideal furnace demanded much more. It must possess not only the capacity of a coal or coke fire, but also accomplish the work in less time, and require but the minimum amount of exertion to operate it. Of the many attempts to produce such, nearly all have failed, owing to technicalities that were not well understood.

"After many experiments, and their accompanying failures, it has been demonstrated that to heat an eight-inch muffle, 3½ by 2½ inches in diameter, to over 2800° F., represents about a one-man power equivalent to the exertion of running the ordinary foot-lathe or the No. 9 bellows, as manufactured by the Buffalo Dental Manufacturing Company, which gives a working pressure of 1½ pounds to the square inch, and corresponds exactly to the required amount of air pressure and volume necessary to heat an eight-inch muffle to 2800° F. Therefore, to make a furnace larger would require too much power, and one smaller would not do for large pieces of work. In the production of a suitable furnace, the whole working apparatus must be as nearly air-tight as possible, the supply of gas and air must be easily controlled and well balanced, with the least amount of friction in the passage through the pipes. These, with many minor details, form the basis of a practical gas-furnace.

Fig. 28.



"GASING THE BODY AND ENAMEL

"The most serious trouble with all gas-furnaces has been the extreme liability of injuring the body and enamel by what has been commonly called 'gasing.' The accompanying illustration, Fig. 28, will make the philosophy of combustion more clear, and give the reasons why teeth are injured. A represents the burner; B B B, fire-brick lining; C C C, combustion chamber; D, interior of muffle. The arrows indicate the direction of the blast. The space in the combustion chamber between the lines E E is where carbon monoxid is formed, a gas containing one equivalent less of oxygen than carbon dioxid, simply an imperfect state of combustion. It is this gas

that injures the body and enamel. By reference to the illustration, it will be seen that the little arrows are made to appear passing through the pores of the muffle, and as the direction of the blast from the burner A is directly against the bottom of the muffle, with a pressure of one pound to the square inch, a portion of the carbon monoxid is extremely liable to be forced through its pores, and will be taken up with the body during the first and second biscuiting, here to remain until the enameling process, and as this takes a much higher degree of heat, it causes the gas to be eliminated, as shown in the numerous small bubbles on the surface. The space between the lines E E, and within the combustion chamber C C C, should be known as the first stage of combustion, where a certain portion of carbon monoxid is always present, and the space above the line F, within the chamber C, should be known as the second stage, which is perfect combustion. In the first stage of combustion one equivalent of oxygen from the atmosphere unites with the hydrocarbon to form carbon monoxid; in the second stage, two, or perhaps three, unite to form carbon dioxid, or carbonic acid. Perfect combustion is always at the extreme point of the blowpipe, as shown in the illustration.

"The attempt, therefore, should be to place the muffle as nearly as possible in the center of perfect combustion. As carbon monoxid is not consumed short of a temperature of over 2200° F., the teeth should be kept in front of the muffle until it approaches a white heat. Starting from a cold muffle this will take about twelve minutes, and they should be gradually carried to the extreme end. At a high temperature, there is very little danger of gasing, unless a greater quantity of gas is supplied than the furnace is capable of burning. Having constructed a furnace, and being familiar with many other details that provided a means to overcome all the apparent difficulties, the success of properly baking teeth seemed to be assured, until the muffle began to crack, which usually started in the second or third enameling heat. This let in such a quantity of monoxid of carbon as to ruin the teeth. Here was a difficulty that was overcome by forcing a quantity of superheated air into the muffle, and backing all foul gases out. This proved to be a cure for gasing, but added an excess of oxygen, and it was found that this had a tendency to bleach the gum-enamel to a lighter shade. The next step was to inject a pure

atmosphere of nitrogen into the muffle, it being a neutral gas, not uniting radically with anything. This was eminently successful, and thoroughly demonstrated the fact that porcelain baked in an atmosphere of nitrogen was absolutely perfect, both in color and texture. It therefore gives me pleasure to be able to announce to the profession that the baking of all kinds of porcelain with any of the hydrocarbons has been brought within the range of every dental practitioner, so that, with a little experience and knowledge of the above facts, artificial teeth can be baked, with unerring precision, in a very comfortable, cheap, and easy manner. By a simple attachment, each furnace produces its own nitrogen as fast as needed, and with recent improvements in the construction of muffles, and the aid of a small motor, the author has been able to maintain a constant and uniform temperature above 2800° F., by which a slab of sectional gum teeth was completed every seven minutes, at the will of the operator.

"OLEFIANT GAS AND GASOLENE.

"Olefiant gas, with which nearly all our cities and towns are supplied, is a compound of hydrogen and carbon. Its symbols are C_2H_4, differing from gasolene only in its specific gravity, the composition of the latter being also C_2H_4. The former will rise to the top of a building, while the latter will fall. *The former is more penetrating, therefore more liable to gas the teeth, and hence requires more care in handling.* The quality varies in different localities, and sometimes, owing to the presence of ammonia, it may injure the teeth, or it may be too thin. When properly purified, it should be a rich hydrocarbon. The uncertainty of its qualities is frequently the cause of failure. To be successful with gas-furnaces, it is absolutely necessary to have a pure and rich hydrocarbon. When the gas pressure is weak or the quality is poor, a gasolene generator may be attached to the pipe and the current allowed to pass through. This takes up a large percentage of the gasolene and provides a very rich quality of gas. The 87 per cent. is the best; 74 per cent. is too heavy to use without requiring heat to vaporize it. By applying to the Combination Gas Machine Company a supply can be had. When pure gasolene is used, it is necessary to have a generator so arranged that a portion of the air from the bellows will pass through it. This carries the vapor

into the furnace, where it becomes mixed with the proper quantity of air, and will produce as good, if not better, results than any other hydrocarbon. All kinds of crucible and muffle work can be done equally well, also soldering and brazing with the blowpipe. One gallon of gasolene costs 15 to 20 cents; this will bake one set of teeth. Therefore it will be seen that dentists living in localities where there is no gas will not be deprived of practically the same advantages as their city brethren."

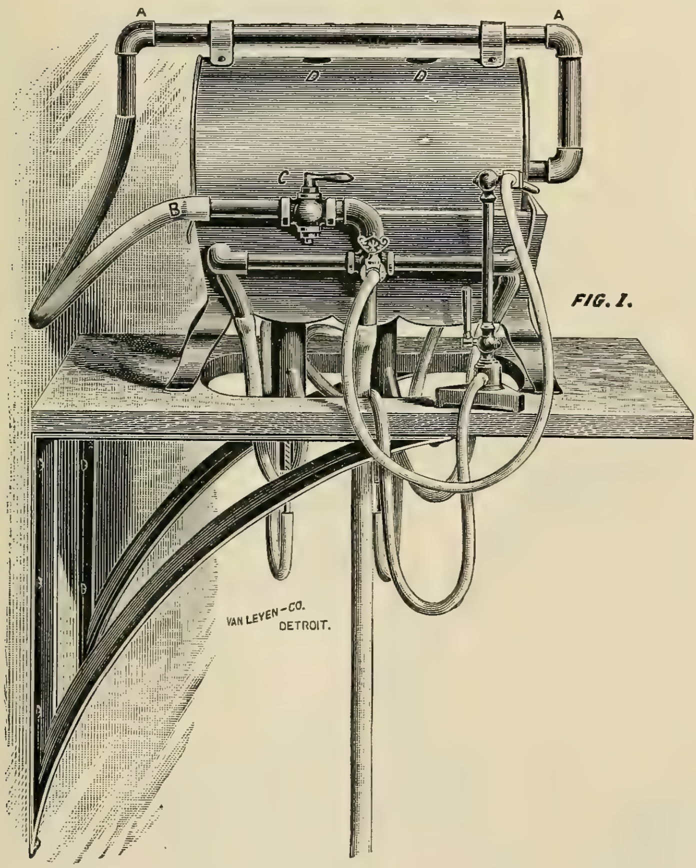
The Land Furnace.—The following is a description of a furnace, invented by Dr. Land, designed especially to overcome the trouble spoken of above, as well as to provide other advantages:

Size No. 1 is especially adapted for all kinds of muffle work, crucible work, blowpipe work, forging and brazing, assaying, and small castings of iron, brass, and steel. A muffle 8 inches long, 3½ inches wide, 2½ inches high, inside measurement, can be heated to over 3240° F. in twenty-five minutes, sufficient to melt wrought iron. Fig. 29 represents the furnace closed and ready for muffle work. A A is an iron pipe, capable of both a sliding and a swinging motion (see L, Fig. 30), to which the door or plug is securely attached. There is a small hole in the door, covered with a piece of mica, through which all operations can be seen. Observe that the iron pipe is connected with rubber tubing, B, and with pipe having an air-cock, C, which regulates the quantity of air passing into the mouth of the muffle. It will also be noticed that the pipe passes over the two holes, D D; thus by the escaping flame the pipe is heated to redness and provides a superheated air before reaching the muffle; this column of air forced into the muffle keeps up a counter-pressure within, so much greater than the pressure produced by the blast within the fire-chamber that all foul gases are prevented from entering the muffle even though it is cracked; thus the most delicate porcelain can be baked without the least danger of so-called gasing. Also, it will be seen that by connecting the rubber pipe with retorts of gasometers any desired vapor or gas could be forced into the muffle, making the furnace invaluable for scientific experiments.

Fig. 30 illustrates the furnace thrown open, being swung on hinges at the back, exposing the muffle, E. The groove, P P, is packed with asbestos fiber, so that when the sections are brought together the furnace will be perfectly air- and gas-tight. The

hooks, F F, are to hold the upper section secure to the lower. The gas and air connections are so arranged that the ordinary blowpipe can be attached, as shown at G. When the muffle, E, is removed, it exposes two burners and a fire-brick surface made to fit the various appliances for crucible, ladle, and blowpipe work. One or both burners can be operated in conjunction with the blow-

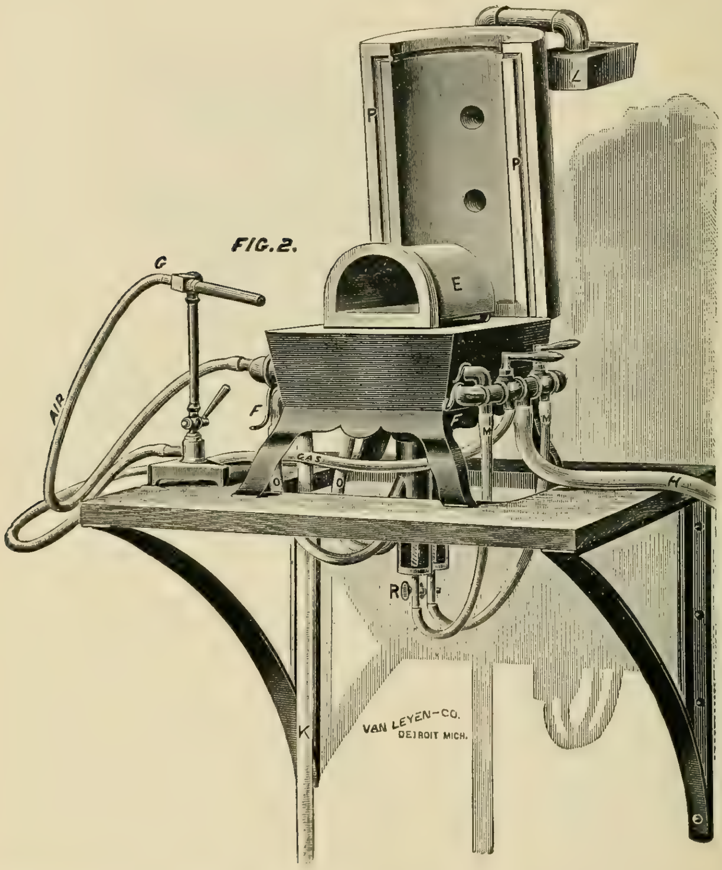
FIG. 29.



pipe, G. The air-cock, R, is to provide a means for shutting off the air supply from either burner when required. H is the gas supply; K, air-pipe connecting with the bellows. Size of muffle, inside measurement, 8 inches long, 3½ inches wide, 2½ inches high. With gasolene gas porcelain teeth can be enameled in from

ten to fifteen minutes; with ordinary city gas in from fifteen to twenty-five minutes, according to quality. In thirty minutes a heat sufficient to destroy the muffle can be produced, which indicates a temperature of over 3240° F., much higher than is ever needed for any kind of work, except the fusing of platinum.

FIG. 30.



Three-eighths of an inch gas-pipe will supply sufficient gas and can be worked with the ordinary foot-bellows.

The Sharpe Furnace.—One of the simplest and most complete gas muffle-furnaces yet placed upon the market, is that invented by Dr. W. M. Sharpe, of Binghamton, New York, and is exhibited in Figs. 31 and 32.

FIG. 31.

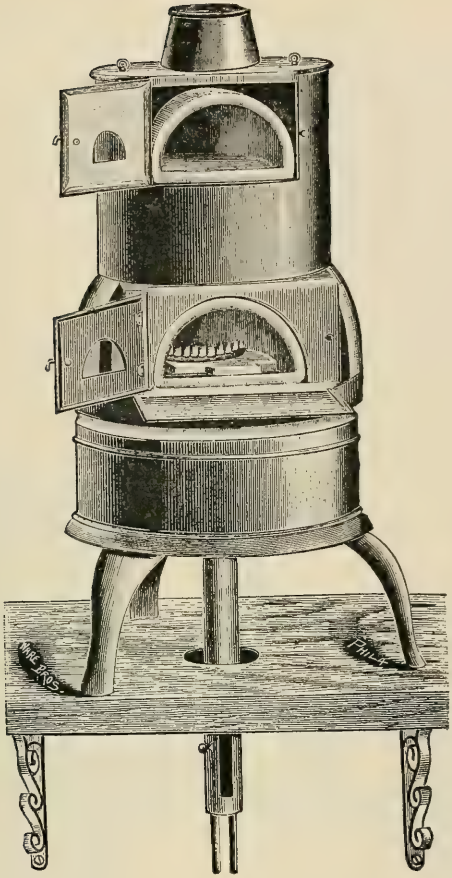
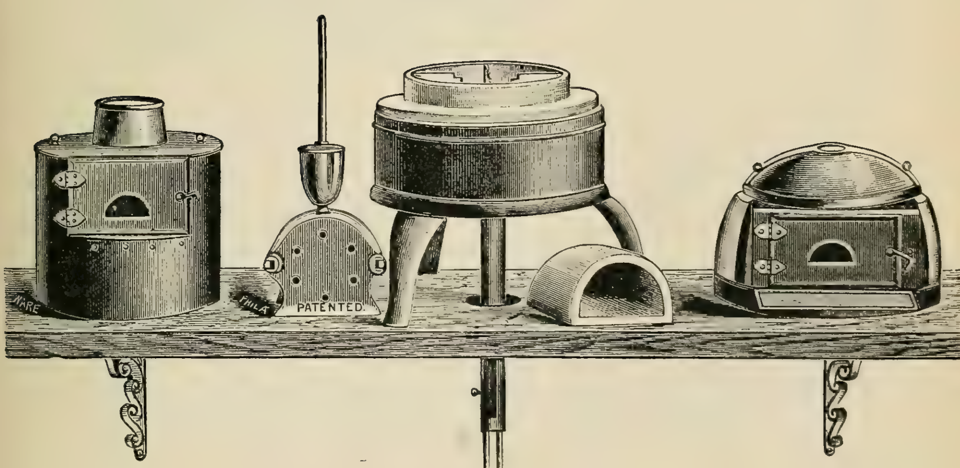


FIG. 32.



Gas Crucible Furnace Without Blast.—Fig. 33 represents a small crucible furnace that will be found very convenient for melting and refining the precious and more infusible metals employed by the dentist. It takes crucibles up to 2½ by 2¼ inches outside, and with a three-foot chimney will melt copper, gold, silver, etc., in about ten minutes, or cast iron in thirty minutes from the time the gas is lighted.

The construction of the burner used with this furnace is illustrated by the sectional diagram, Fig. 34, and is thus described:

FIG. 33.

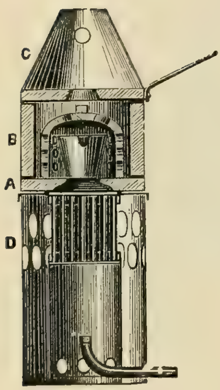
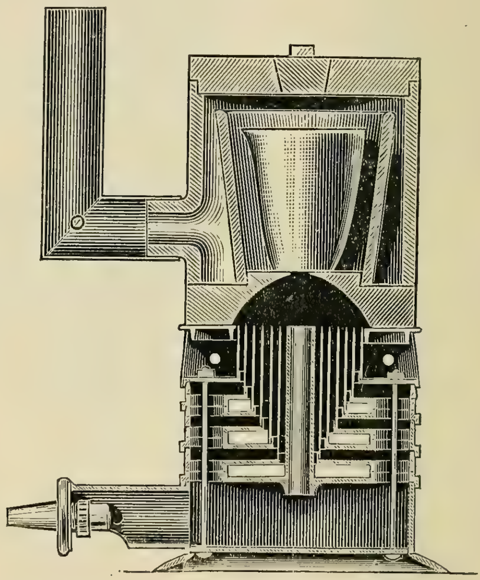


FIG. 34.



"The gas enters a chamber at the bottom of the burner, through a device similar to a Bunsen burner, mixing with air as it enters, and is burned at the upper ends of a series of concentric tubes, furnishing air-spaces alternately with those supplying the mixture of gas and air. The whole burner is constructed of iron, and will be found better able to withstand an intense heat, more durable and quicker in its operation, than the old pattern with gun-metal tubes. In case metal should be spilled into the burner, it can be easily taken apart for its removal.

"Each part of the burner is lettered, and in case of accident it

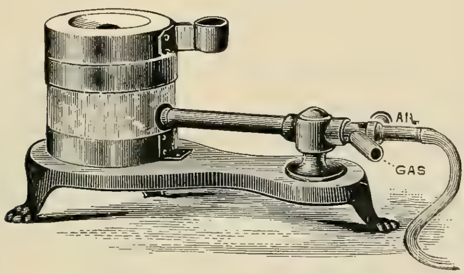
can be supplied at a small expense by specifying the letter on the piece desired.

"The burner in its present shape is believed to be the most efficient and economical yet devised for furnace purposes."

The following instructions in the use of this furnace should be observed:

"A chimney or stove-pipe, eight or ten feet high, may be used as a fixture, and the draft partially stopped with a damper or slide when lower temperatures are required, the gas being turned down in proportion; the guide for the proper adjustment being that UNDER ALL CIRCUMSTANCES THE FLAME MUST JUST COVER THE CRUCIBLE OR MUFFLE, but not extend into the chimney so as to make it red hot. When the flame covers the crucible or muffle the

FIG. 35.



gas is doing its extreme duty under the most favorable circumstances, without waste. Particles of flux should not be allowed to fall on the fire-clay casing, where the parts touch each other; and the power of the furnace should not be urged too far by the use of very long chimneys, as there is danger of the fusion of the fire-clay parts together, so that they cannot be separated. Fire-clay fittings, as a rule, cannot be safely used for temperatures much exceeding the fusing-point of cast iron. *Plumbago fittings and crucibles must be heated slowly the first time they are used.* After the first time they may be subjected instantly to the full power of the furnace without injury."

Gas Crucible Furnaces with Blast.—A small, compact, and convenient crucible furnace is shown in Fig. 35. Of this simple but powerful heating-apparatus, which will be found especially

adapted to the necessities of the dental laboratory, the manufacturers* observe:

"Owing to the discovery, by Mr. Fletcher, of a singularly perfect non-conducting furnace casing, we are enabled to produce the first really simple gas-furnace ever constructed. This material is only about one-sixth the weight of fire-clay, and has not one-tenth its conducting power for heat.

"The furnace consists of a simple pot—for holding the crucible—with a lid and a blowpipe, all mounted on a suitable cast-iron base. As compared with the ordinary gas-furnace it appears almost a toy, owing to its great simplicity.

"The casing holds the heat so perfectly that the most refractory substances can be fused with ease, using a common foot-blower. Half a pound of cast iron requires from seven to twelve minutes for perfect fusion, the time depending on the gas supply and pressure of air from the blower.

"The power which can be obtained is far beyond what is required for most purposes, and is limited only by the fusibility of the crucible and casing.

"The crucible will hold about ten ounces of gold.

"An ordinary gas supply pipe, $\frac{5}{16}$ or $\frac{3}{8}$, will work it efficiently. It requires a much smaller supply of gas than any other furnace known. About ten cubic feet per hour is sufficient for most purposes.

"Crucibles must not exceed 2¼ by 2 inches. Any common blowpipe bellows will work the furnace satisfactorily except for very high temperatures (fusion of steel, etc.), for which a heavy pressure of air is necessary.

"In adjusting this furnace for use, put the gauze-nozzle of the burner closely against the hole in the side of the casing, turn on the gas, and light it in the furnace. Work the bellows and then put the cover on the furnace. The air supply should be such that a flame about two inches long will play out of the hole in the cover, and it may be adjusted by turning the thumb-screw on the side of burner. The amount of air and gas used by this burner is very small. Care should be taken that the right proportion of each should be used. A *very light* but steady blast of air will give the best results.

* Buffalo Dental Manufacturing Company.

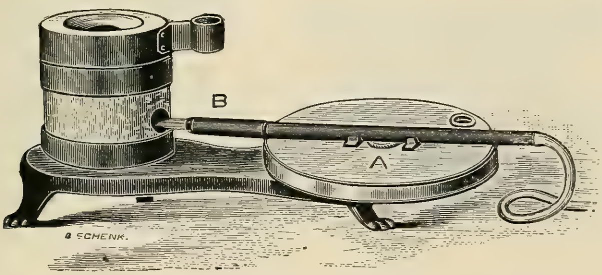
"A modified pattern of the foregoing furnace (Fig. 36) has been designed, retaining all the peculiar advantages of the one just described, but burning refined petroleum instead of gas as fuel, and is claimed to be equally as efficient as the gas-furnace.

"The burner of this furnace is constructed upon the principle of an atomizer; and this, of course, dispenses with a wick. This method has proven the most efficient of any that has been experimented with.

"The recent improvements consist in a device for regulating the supply of oil, which is operated by the milled nut (marked A) shown on top of the reservoir in the cut, and the addition of an annular jet of air, which is regulated by turning the sleeve (marked B)."

This is an approved crucible furnace, and is known as Fletcher's injector gas-furnace, the construction of this apparatus being

Fig. 36.



upon the principle of the injector furnace, and it is claimed that its power and speed of working are practically without limit, depending only upon the gas and air supply. It is very simple in construction, and consists of two parts, an upper portion, which forms the cover, and a lower part, which holds the crucible while in operation (see Fig. 36).

A very useful and almost indispensable heating-apparatus in the dental laboratory, suitable for drying, boiling, melting metals requiring a moderate temperature, as zinc, tin, lead, etc., heating flasks preparatory to packing with rubber, and a variety of other purposes, is exhibited in Fig. 37.

The burner, consisting, as will be seen, of a circular perforated gas-tube with a central air-jet, gives a complete range of tempera-

ture, from a gentle current of warm air to a clear red heat, and is so perfectly under control that a common glass bottle may be placed on the tripod and heated to any required temperature without the slightest risk of fracture. For very low temperatures the ring must be lighted through the opening B. This gives a steady current of heated air through the gauze above. For boiling, melting, etc., the light must be applied on the surface of the gauze, thereby providing a large body of blue flame, which can be urged by the blastpipe C. This is one of the most generally useful burners, and stands hard, dirty work without injury. The gauze, if choked up with dirt, can be replaced in a few seconds.

An equally convenient heater for many purposes requiring a diminished temperature, as compared with the air-blast heater

Fig. 37.

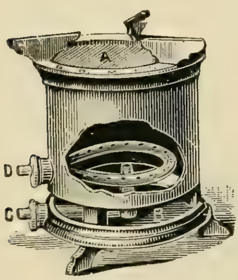
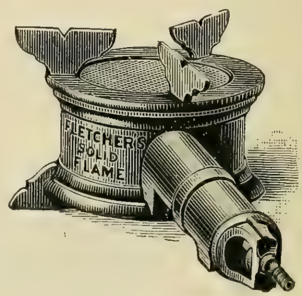


Fig. 38.



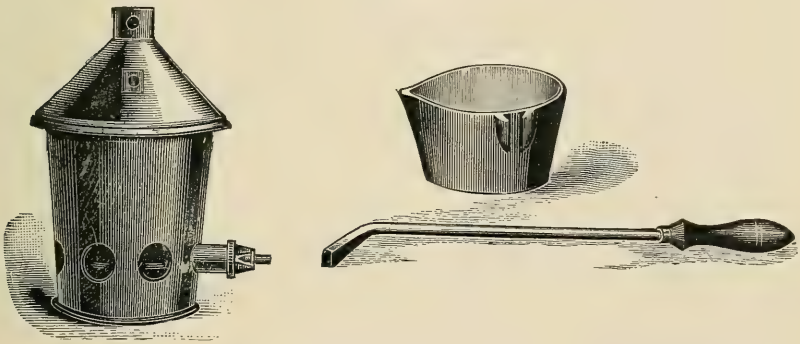
just described, is exhibited in Fig. 38. A gentle current of air passes through side openings in the end of the injecting tube, mingling with the gas supplied through a rubber tube attached to an ordinary gas-burner.

An admirably contrived ladle-furnace, designed by Dr. Fletcher, is shown in Fig. 39. This simple contrivance, provided with a heating apparatus similar to the burner last described, is especially well adapted for melting any of the several metals usually employed for dies and counter-dies, as zinc, tin, lead, Babbitt metal, etc. The burner can be removed from the casing and used for other purposes if desired. A cast-iron ladle of suitable form, with a detachable handle, which can be removed during the process of melting, is also illustrated.

CRUCIBLES.

Crucibles are small, conical-shaped vessels used by the dentist principally for the purpose of melting and refining metals used for plates, compounding metallic alloys, preparing and compounding the various ingredients employed in the manufacture of porcelain teeth, continuous-gum work, etc. They combine in a high degree the properties of infusibility, exemption from the attack of substances fused in them, the power of resisting sudden alternations of temperature and impermeability to fluids and gases. The Hessian crucibles, which are in most common use among dentists, are composed of silica, alumina, and oxid of iron.

FIG. 39.



Plumbago crucibles are also made from special patterns, and expressly designed for Fletcher's furnaces.

To avoid a possible loss of fused metals, which may occur in consequence of some imperfection in the crucible, a test should be made by placing in it a small quantity of borax and then subjecting it to a high heat. If imperfect, the borax, rendered semifluid by the heat, will pass through the substance of the crucible and glaze the surface on the outside.

PRINCIPLES OF SOLDERING.

Successful soldering is dependent upon several conditions, a disregard of any one of which may mean much difficulty, or a complete failure. By the close observance of these conditions

the difficulties experienced in soldering (especially by students) may be reduced to a minimum, in fact the operation becomes very simple. These conditions are:

First, contact of the two surfaces to be united. If, for instance, the ends of a piece of plate are to be united, as in the formation of a band or ferrule, they must be so shaped as to be in close apposition at every point, as solder will not bridge a space. Or, if it be the soldering of an artificial denture, the backings must be in *contact* with the plate to which they are to be united. In other words, the continuity of the metal must be complete at the points where it is desirous to have the solder flow.

Second, cleanliness of the surfaces over which the solder is to flow. That cleanliness in soldering operations should be observed, is quite as necessary as that the surfaces to be united should be in perfect contact. The purity of gold or silver is usually reduced by alloying with copper, which readily oxidizes when the metal is heated to redness. This oxidation can be readily removed by immersing the piece, when practicable, in dilute sulphuric acid, slightly heated; or a strong solution of alum may be used—its solvent properties, however, are not developed until brought to the boiling-point, 212° F. Borax is also employed for this purpose; it accomplishes the same result by dissolving the oxid from the surface of the metal at the points where applied, and at the same time protects it from further oxidation. A good practice is to coat the surfaces to be soldered, before the heat is first applied.

Third, the proper amount and application of heat. Where artificial teeth are to be soldered the heating process, as well as the cooling, should be gradual. The greater the amount of investment material, the greater the amount of heat required to bring the piece to be soldered to a uniform temperature. It naturally follows that the *thickest part* of the investment must receive the greatest volume of heat. Solder always flows toward the hottest point; this tendency enables us to direct its course under the blowpipe, by keeping the parts to be soldered at a higher temperature than the solder itself. On the other hand, if the heat is directed upon the solder, so that it reaches its fusing-point before the parts upon which it is placed are equally hot or hotter, it rolls up into a ball, a very troublesome feature to the majority of students. A large flame from the blowpipe should only be employed

in " heating up " the case, *not* for the soldering process. If these three stages have been carefully observed, it will be found that with *a small pointed* flame directed upon the solder and the parts to be united, the solder will flow quickly and leave a smooth, even surface at the completion of the operation.

CHAPTER III.

METALS EMPLOYED IN DENTAL LABORATORY OPERATIONS.

GOLD.

Au (Aurum).

Gold has been known from a period of great antiquity, having, according to the writings of Moses, been wrought into articles of jewelry more than three thousand years ago. As a base or support for artificial dentures, it has entirely superseded the use of the various animal substances formerly employed, and, by the mass of practitioners at the present time, it continues to be the most highly esteemed metal for the purpose mentioned, notwithstanding the more recent introduction of processes in which, as a base, this metal is wholly discarded.

Gold is found in nature chiefly in the metallic state, and occurs either crystallized in the cube and its allied forms, or in threads of various sizes, twisted and interlaced into a chain of minute octahedral crystals; also in spangles or roundish grains. These latter, when they occur of a certain magnitude, are called *pepitas*, some specimens of which have been obtained of great size. In 1810 a mass of alluvial gold weighing 28 pounds was found in the gravel-pits of the creeks of Rockhole, in North Carolina. A lump of gold ore weighing three cwt. was forwarded from Chili, South America, as a contribution to the World's Exhibition in London. New Granada, California, Russia, and Australia have each produced pepitas, or masses of gold weighing respectively 27½, 28, 70, and 106 pounds. As it occurs in nature, gold is never quite pure, being generally associated with silver, though sometimes it contains small quantities of platinum, iridium, or palladium.

Geological Situations.—The crystalline primitive rocks, the compact transition rocks, the trachytic and trap rocks, and alluvial grounds are the formations in which gold occurs. Unlike many other metals, it is never in such large quantities as to constitute veins by itself, but is either disseminated through the

rocky masses, or spread out in thin plates or grains on their surface, or confined in their cavities in the shape of filaments or crystallized twigs. The minerals composing the veins are either quartz, calcspar, or sulphate of baryta. The ores associated with the gold in these veins are principally iron, copper, arsenical pyrites, galena, and blende. The most abundant sources of gold, however, are in alluvial grounds, where it is found distributed in the form of spangles in the sands of certain plains and rivers, especially at their reëntering angles, at the season of low water and after storms and temporary floods. Sufficient reasons have been advanced in support of the belief that gold found in alluvial situations belongs to the grounds traversed by these rivers, instead of being washed, as was formerly supposed, from the mountains in which their waters have their origin.

Geographical Distribution.—The *European* mines more particularly distinguished for their richness are in Hungary and Transylvania; it also occurs, but more sparingly, in Ireland, Sweden, Siberia, Germany, Russia, Spain. In *Asia* and *Africa,* the mines which yield most abundantly are situated in the southern portion of these continents. From the latter, the ancients derived the greater portion of their gold. Several of the *South American* provinces yield this metal in considerable quantities. Washings are also common in several States of the Union, but California stands unrivaled, except by Australia, in the immense productiveness of its mines, and its resources in respect to this rare and valuable metal are reckoned inexhaustible.

Properties of Gold.—Pure gold is distinguished from all other metals by its brilliant orange-red or yellow color, being the only simple metal that possesses this complexion. It is susceptible to a high polish, but is inferior in brilliancy to steel, silver, or mercury. Its specific gravity varies somewhat, according as it is fused or hammered; the former having a density of 19.26, the latter ranging from 19.04 to 19.65. It is only excelled in density, therefore, by platinum, the specific gravity of which is 21.25.

Gold surpasses all other metals in malleability. The average thickness of ordinary gold-leaf is $\frac{1}{282000}$ of an inch, but the ultimate degree of attenuation to which pure gold is susceptible exceeds considerably this estimate. It is also distinguished for its ductility. A single grain of gold may be drawn into wire 500

feet in length, while an ounce may be made to extend 1300 miles. It is somewhat softer than silver, and possesses great tenacity, though inferior in this quality to iron, copper, platinum, or silver. A thread of gold $\frac{78}{1000}$ of an inch in diameter will sustain a weight of 150 pounds.

The fusing point of gold is 2016° F. It fuses with considerable expansion, and on cooling contracts more than any other metal.

On account of the want of affinity of gold for oxygen, it remains unaltered in the longest exposure; it is incapable of being oxidized in any heat that may be applied to it, and is only volatilized with great difficulty in the resistless heat of the oxyhydrogen blowpipe. It is unaffected by the most concentrated of the simple acids, but is readily soluble in *aqua regia* or nitro-muriatic acid and nitro-fluoric acid.

It will thus be seen that gold possesses, in an eminent degree, those general properties which render it peculiarly fit for the purposes to which it is applied in the practice of dental prosthesis.

Influence of Alloying on the Properties of Gold.—The term *alloy* signifies a compound of any two or more metals, as brass, which is an alloy of copper and zinc.

Alloys, in respect of their uses, are practically new metals, and differ in many important respects, both in their chemical and physical characteristics, from the constituent metals of which they are composed. A more particular account of the influence of alloying upon the general properties of metals, and their management and behavior in the process of compounding, will be given under the head of alloys of the baser metals. As gold combines readily with most metals, some of the more prominent conditions which distinguish its alloys will be given.

The malleability of gold is, strictly speaking, always impaired by its union with other metals. This effect is eminently characteristic of certain contaminations, as those with arsenic, tin, antimony, bismuth, lead, etc.; while with certain other metals, as silver, copper, and platinum, unless in excess, this property of gold is so little affected, as in no material degree to interfere with its being worked into any desired form for dental purposes. The *ductility* of gold is also usually diminished by its incorporation with foreign metals; sometimes in a remarkable degree. Gold is

always rendered *harder,* and its *tenacity* is generally increased, by alloying, while its *density* varies with the particular metal or metals with which it is combined. Thus the alloy of gold with either zinc, tin, bismuth, antimony, or cobalt, has a density greater than that of the mean of its constituents, while the alloys of gold having a less specific gravity than the mean of their components are those with silver, iron, lead, copper, iridium, or nickel. Gold is ordinarily *more fusible* when alloyed, the alloy always melting *at a less heat than that required to fuse the most refractory constituent, and oftentimes less than the more fusible component.* The alloy of gold and platinum furnishes an example of the former; the platinum, which in its uncombined state is infusible in the highest heat of a blast-furnace, forming a fusible compound with gold, the melting-point of which is far below that of platinum. Gold solder, composed of gold, copper, and silver, affords a familiar illustration of the latter, the alloy melting at a less heat than that required to fuse its least refractory component, silver. Gold, which in its pure state has less affinity for oxygen than any other metal, is rendered more or less oxidizable when combined with other metals.

That gold alloys tend to be formed in definite proportions of their constituents would appear from the phenomenon observed in the native gold of the auriferous sands, which is an alloy with silver in the ratio of one atom of silver, united to four, five, six, or twelve atoms of gold, but never with a fractional part of an atom. The same circumstance is noticed in connection with the amalgam of silver and mercury. But as alloys are generally soluble in each other, the definiteness of this atomic combination is obscured and disappears in most cases.

Properties of Particular Alloys of Gold.—The metals with which gold is liable to be contaminated in the dental laboratory are zinc, tin, lead, antimony, bismuth, iron or steel, mercury, and arsenic; as also excess of silver, copper, and platinum. As several of these metals when alloyed with gold, even in very minute quantities, are highly destructive in their influence upon those properties which adapt this metal to the various wants of the mechanical operator, and as their separation is often attended with considerable difficulty, annoyance, and loss of time, it is practically important that care should be taken to prevent, as far as practicable, the admixture of any one or more of them with the gold scrap, fil-

ings, or sweepings, that are to be reconverted into proper form for use. The accidental intrusion of these metals, however, is, to some extent, unavoidable, and as an acquaintance with the more prominent characteristics or sensible properties of the resulting alloys sometimes furnishes valuable indications in the selection of the proper reagents employed in their purification, a description of individual alloys is introduced.

Tin, antimony, bismuth, lead, and arsenic, are peculiarly prominent in their effects upon the malleability of gold; either of these metals in exceedingly minute quantities render gold intractable.

One part of *antimony* with nine parts of gold, form a pale, brittle alloy, and in the proportion of one part of the former to 1920 of gold, the resulting compound is too brittle to admit of successful lamination.

An alloy of *arsenic* with gold containing $\frac{1}{240}$ of the former is a gray, brittle metal, while in the proportion of $\frac{1}{900}$, the malleability of the gold is seriously impaired without suffering any change of color. So energetic is the influence of this metal on gold that the latter is rendered brittle when subjected even to the vapor of arsenic.

Tin, lead, and bismuth are somewhat analogous to arsenic in their influence upon the malleability of gold, either of them, in almost inappreciable quantities, rendering the latter metal unmanageable under the rollers. One part of lead or bismuth to 1920 of gold converts the latter into an unmalleable metal, while tin exceeds either in its remarkable tendency to render gold hard and brittle. Alloys of gold with tin are of a light color; those with lead are of a darker complexion.

Zinc with gold forms a brittle alloy, and when combined in equal proportions is exceedingly hard, white, and brittle. Uniting or incorporating itself less intimately with the gold than either lead or tin, however, it not infrequently happens that portions of the ingot will be brittle while others remain, in some degree, malleable; so that the bar, when rolled out in the form of plate, will be perforated or cracked at those points where the zinc predominates, while remaining portions of the plate retain a moderate degree of softness and pliability.

The working properties of gold are not sensibly affected by the

incorporation of very small quantities of *iron,* as an alloy of these metals, in the proportion of one part of the latter to eleven of gold, remains malleable.

Platinum, in itself a highly refractory metal, is, as before stated, rendered fusible in combination with other metals. When combined with gold in small proportions, the latter is rendered harder and more elastic without having its malleability practically impaired. Platinum very readily affects the color of gold, the smallest quantities rendering the alloy pale and dull-colored.

Silver unites with gold in every proportion, and is the chief metal employed in the reduction of gold to the required forms for dental uses. It renders gold more fusible, and imparts to it increased hardness without materially affecting its malleability. The alloy is light-colored in proportion to the amount of silver introduced.

Copper, like silver, is usually combined with gold in the formation of plate, solders, etc., and hardens and renders gold tougher without practically impairing its malleability. It imparts to the alloy a deeper red color, and in the form of plate is capable of receiving a polish excelling in richness and brilliancy any other metal.

The foregoing alloys of gold, it will be perceived, are such as result from the incorporation with gold of minute proportions of any one of the base metals mentioned, and possess certain physical characteristics that indicate, with tolerable certainty, the particular alloying component. Thus, for example, if the alloy is light-colored and very brittle, the presence of tin may be suspected; if brittle and dull-colored, lead is indicated; if grayish or dull-colored, but still malleable, tough, and elastic, platinum is probably present; if unequally malleable, or brittle in spots, the presence of zinc may be inferred.

Alloys of gold, however, embracing several or all of these metals in varying proportions, are sometimes accidentally formed, in which case the more distinctive features which characterize the binary compounds are lost or obscured.

CHAPTER IV.

REFINING GOLD.

Elements Employed.—The separation of foreign metals from gold by what is termed the "dry method," or *roasting*, is effected by the action on them of either oxygen, chlorin, or sulphur, converting them into oxids, chlorids, or sulphurets. Certain compound substances are used for this purpose which, when heated and decomposed, yield these elements in sufficient quantities for the purposes specified. The refining agents in common use are *nitrate of potassa* (niter, or saltpeter), which yields oxygen; *chlorid of mercury* (corrosive sublimate), which yields chlorin; and *sulphuret of antimony* (crude antimony), which yields sulphur. Other compounds contain these elements, but those mentioned are generally preferred because they contain them abundantly, are readily decomposed by heat, and do not materially interfere with the process of separation by the introduction of troublesome components into the alloy.

Before considering specifically the different modes of refining alloys of gold, it will be convenient to classify the different forms of gold as they occur in working this metal in the laboratory.

1. Plate-scrap or clippings, and plate-filings. These, if proper care is taken to prevent the introduction of fragments of platinum, impure filings, or particles of base metals, only require, provided they were originally of suitable fineness, to be remelted and again converted into plate or other forms for use.

2. Mixed filings, and fragments containing solder, platinum, etc. These, when melted alone, produce an alloy more or less impoverished in proportion to the quantity and quality of the foreign metals introduced in finishing pieces constructed of gold, and should either be separately refined by roasting, or reduced to pure gold by the "humid method," to be described hereafter.

3. Sweepings. This form embraces many impurities, earthy and metallic, and should first be thoroughly washed, to remove

the earthy constituents, after which the remaining metals may either be mixed with class second, or separately refined. Another and perhaps better method, is to fuse together the sweepings and substances hereinafter mentioned, in the following proportions: Of sweepings, eight parts; chlorid of sodium, four parts; impure carbonate of potassa, four parts; impure supertartrate of potassa, one part; and nitrate potassa, half part. Mix them thoroughly together, and melt in a crucible. The crucible with its contents should remain in the fire for some time, in order to secure a complete separation of the metals from extraneous matter.

It is evident from the above classification that much time and labor may be saved by preserving these forms of gold separately as they accumulate in the laboratory. Separate lap-skins or receptacles, therefore, should be appropriated to the working of gold, one to receive scrap and unmixed plate-filings, which may be reconverted into plate without refining; another to collect the solder-filings, and such impure fragments as require purification.

Separation of Foreign Metals from Gold.—The most troublesome ingredients which find their way into gold alloys are what are commonly called *base* metals, as tin, lead, zinc, iron, antimony, bismuth, etc. In attempting to separate these metals from gold, it is not a matter of indifference what reagent is employed, inasmuch as distinct affinities exist, which may be advantageously consulted. If, for example, zinc, or iron, or both of these metals are present in small quantities, any compound which yields oxygen will, by virtue of the affinity of the latter for these metals, effect their separation by converting them into oxids; hence, when these metals are to be got rid of, nitrate of potassa is employed. But oxygen has a feeble affinity for tin, and when this metal is present, its separation is better effected by some compound which parts with chlorin in the act of decomposition; chlorid of mercury is therefore used for the purpose. When the alloy of gold contains a number of these metals at the same time, and is very coarse, sulphuret of antimony, which is a very powerful and efficient reagent, should be resorted to, unless the operator should prefer, and which is the better way, to reduce the alloy to pure gold by the "humid method."

The Dry Method.—After all traces of iron or steel have been removed from the gold fragments and filings by passing a magnet

repeatedly through them, the latter should be placed in a clean crucible, lined on the inside with borax, and covered either with a piece of fire-clay slab, or broken crucible. Sheet-iron has been recommended for the latter purpose, *but should never be used, as, when highly heated, scales form on the surface, and are liable to drop in upon the fused metals.* If the operation is likely to be protracted, an inverted crucible, with a hole in the bottom, may be securely luted to the top of the one containing the metals; the refining agents and fluxes being introduced through the opening in the upper crucible. These are then placed in the furnace, on a bed of charcoal, or what is better, a mixture of charcoal and coke, the latter being built up around the crucible, and over it when covered with a second crucible, care being taken that no fragments of fuel are permitted to fall in upon the fused metals. The process is as follows:

First melt the alloy at a high temperature, to oxidize the base metals; the refining agents may then be added in small quantities from time to time, and the heat continued from half an hour to an hour, according to the coarseness of the alloy. The agents first employed are borax, and potassium nitrate (KNO_3). The latter assists the oxidation by parting with its oxygen, when the foreign metals will generally become entirely oxidized and dissolved in the slag.

The crucible should be removed from the fire, and the metals allowed to cool gradually. The crucible may now be broken and the button of gold at the bottom removed and separated from the slag that covers it with a hammer. The gold should then be put into a fresh crucible and remelted for pouring into ingot-molds, which should be previously warmed and oiled (see page 89). This treatment, with nitrate of potassa and borax, will usually be sufficient, as most metals are oxidizable. If, however, after hammering, annealing, and rolling the ingot, it should still be found brittle, it must be remelted, and some other refining agent employed to remove the traces of the base metals. If it is known what foreign metal is present, the particular reagent which will most readily attack it should be used. But if, as is often the case, the alloy is of uncertain composition, or contains several metals having distinct affinities, the process becomes to some extent experimental, making it necessary to use first one refining agent

and then another, until, from the appearance and the manipulation of the gold, it is found to be free from alloy. The special reagents employed are as follows:

When tin or lead is present, add mercuric chlorid, $HgCl_2$ (corrosive sublimate), and zinc chlorid, $ZnCl_4$, or lead chlorid, $PbCl_2$, are formed and with the mercury volatilized by the heat.

When silver is present, add to the molten alloy from two to four times its weight of antimony sulphid, Sb_2S_3; this must be added carefully and a little at a time. The heat decomposes the sulphid. The sulphur unites with the silver and other base metals, forming sulphids, while the antimony unites with the gold, forming a leaden-colored alloy. When effervescence has ceased, remove the crucible from the fire and allow it to cool. The antimony and gold alloy will be found in the bottom of the crucible, and the sulphids on the surface.

To separate the antimony from the gold, remelt the alloy and throw upon the molten mass a current of air from a blowpipe. Antimony oxid, Sb_2O_3, is formed and volatilized; continue the process until fumes cease to be given off.

When iridium is present, Prof. Essig, in writing upon the subject, says: "The little, hard grains occasionally met with in gold, upon which the file makes no impression, consist of iridium, or a native alloy of osmium and iridium, and are not combined with the gold, but merely disseminated through it. The only dry method of separating it from gold consists in alloying the latter with three times its weight in silver, by which means the specific gravity of the metal is so much lowered that iridium, which is very infusible and of a specific gravity of 21.1, will subside to the bottom of the crucible, when the gold and silver alloy may be poured or ladled off. As some of the gold will remain with the residue, more silver must be melted with it, the operation being repeated several times until nearly all the gold is removed." The gold and silver alloy may then be separated as directed above.

When Platinum is Present.—If, after treating the alloy with the reagents enumerated, it should be found malleable, but stiff or elastic, and of a rather dull color, it is due to the presence of platinum; and any further attempts to reduce it by the "dry process" will prove unavailing. It must then be subjected to what will hereafter be described as the "humid or wet method."

The Humid Method.—When it is desired to reduce the alloy to pure gold, which is generally advisable whenever the gold to be refined consists of very coarse filings, fragments of plate containing large quantities of solder, linings with platinum pins attached, particles of base metals, etc., the "humid or wet method," as it is called, should be employed. The solvents in common use for this purpose are nitric, sulphuric, and nitro-muriatic or hydrochloric acid; but as the desired results can be more conveniently and directly obtained by the use of the latter, or hydrochloric acid, this most available method alone will be given. The following practical remarks on the subject are from an article on the "Management of Gold,"* by Professor George Watt:

"When the alloy is composed of metals differing but little in their affinities for oxygen, chlorin, etc., we resort to one of the 'wet methods.' And, in connection, we will only describe the one which we consider the most convenient and effectual for the practical dentist. It is effectual in all cases, as it always gives us pure gold.

"Let us, then, suppose that our gold alloy has become contaminated with platinum to such an extent that the color and elasticity of the plate are objectionable. The alloy should be dissolved in nitro-muriatic or hydrochloric acid, called *aqua regia.* The best proportions for aqua regia are three parts of hydrochloric acid to one of nitric. If the acids are at all good, four ounces of the aqua regia will be an abundance for an ounce of the alloy. The advantage of using the acids in the proportion of three to one, instead of two to one, as directed in most of the text-books, is, that when the solution is completed there is but little, if any, excess of nitric acid. If the acids be 'chemically pure,' four parts of the hydrochloric to one of the nitric produces still better results.

"By this process the metals are all converted into chlorids; and, as the chlorid of silver is insoluble, and has a greater specific gravity than the liquid, it is found as a grayish-white powder at the bottom of the vessel. The chlorids of the other metals, being soluble, remain in solution. By washing and pouring off, allowing the chlorid of silver time to settle to the bottom, the solution may be entirely separated from it.

"The object is now to precipitate the gold while the others re-

* *Dental Register of the West,* vol. xii, p. 251.

main in solution. This precipitation may be effected by any one of several different agents, but we will mention only the protosulphate of iron.

"This salt is the common green copperas of the shops, and, as it is always cheap and readily obtained, we need look no further. It should be dissolved in clean rain-water, and the solution should be filtered, and allowed to settle until perfectly clear. Then it is to be added gradually to the gold solution as long as a precipitate is formed, and even longer, as an excess will the better insure the precipitation of all the gold. The gold thus precipitated is a brown powder, having none of the appearances of gold in its ordinary state. The solution should now be filtered, or the gold should be allowed to settle to the bottom, where it may be washed after pouring off the solution. It is better to filter than decant in this case, as, frequently, particles of the gold float on the surface, and would be lost in the washings by the latter process.

"Minute traces of iron may adhere to the gold thus precipitated. These can be removed by digesting the gold in dilute sulphuric acid; and, when the process is properly conducted thus far, the result is *pure gold,* which may be melted, under carbonate of potash, in a crucible lined with borax, and reduced to the required carat."

CHAPTER V.

ALLOYS OF GOLD FOR DENTAL PURPOSES.

Gold in its pure state is rarely employed by the dentist in laboratory processes, on account of its softness and flexibility; it is, therefore, usually alloyed with such metals as impart to it—without practically impairing either its malleability, pliancy, or purity—the degree of hardness, strength, and elasticity necessary to resist the wear and strain to which an artificial piece constructed from it is unavoidably exposed in the mouth.

Reducing Metals.—The metals with which gold is usually combined are copper and silver. It is sometimes reduced with silver alone, many regarding the introduction of copper into the alloy as objectionable, as plate derived from it is supposed to be more readily tarnished and to communicate to the mouth a disagreeable metallic taste. This is unquestionably true, if, as is sometimes the case, the copper used is in excess; when, in addition to the effects mentioned, gold, so debased, may become a source of positive injury to the organs of the mouth, as well as to the general health. The small proportions of copper usually employed in forming gold plate, however, are not likely to produce, in any objectionable degree, the consequences complained of, unless the fluids of the mouth are greatly perverted. If gold coin is used in the formation of plate, it may be sufficient to add silver alone, inasmuch as copper is already present; though, usually, additional quantities of the latter metal are added.

Required Fineness of Gold Plate.—Alloys of gold to be permanently worn in the mouth should be of such purity as will most certainly, under all the contingencies of health and disease, resist any chemical changes that would tend to compromise either the comfort or health of the patient. Evils of no inconsiderable magnitude are sometimes inflicted, either through ignorance, carelessness, or cupidity, by a disregard of this important requirement. If the general health of the patient remained always uniformly unim-

paired, with the secretions of the mouth in their normal state, gold degraded to 18 or even 16 carats fine, would undergo no material changes in the mouth. But it must be remembered that, in addition to the corrosive agents introduced into the mouth from without, a variety of diseases, local and constitutional, effect important changes in the otherwise bland and innoxious fluids contained therein, which, from being alkaline or neutral, become more or less acidulated. Indigestion, with acid eructations; gastro-enteritis; ague; inflammatory and typhoid fevers; brain affections; eruptive diseases; rheumatism, gout, etc., are some of the local and constitutional disorders almost uniformly imparting to the mucous and salivary secretions an acid reaction. When this condition of the secretions exists in connection with the use of gold, readily acted on chemically by reason of its impoverishment, some degree of irritation of the tissues of the oral cavity is likely to ensue. Gold plate intended to be introduced into the mouth should not, therefore, as a general thing, be of a less standard of fineness than from 18 to 20 carats. It may exceed this degree of purity in some cases, but will rarely or never, unless alloyed with platinum, admit of being used of a higher carat than the present American coin, which is 21.6 carats fine.

Formulas for Gold Plate used as a Base for Artificial Dentures.—Any of the following formulas may be employed in the formation of gold plate to be used as a base or support for artificial dentures. The relative proportions of the alloying components may be varied to suit the peculiar views or necessities of the manipulator. The estimated carat of the appended formulas is based on the fineness of the American gold pieces coined in 1837 and thereafter.

GOLD PLATE EIGHTEEN CARATS FINE.

Formula No. 1.	*Formula No. 2.*
18 dwts. pure gold,	20 dwts. gold coin,
4 dwts. fine copper,	2 dwts. fine copper,
2 dwts. fine silver.	2 dwts. fine silver.

GOLD PLATE NINETEEN CARATS FINE.

Formula No. 3.	*Formula No. 4.*
19 dwts. pure gold,	20 dwts. gold coin,
3 dwts. copper,	25 grs. copper,
2 dwts. silver.	40 + grs. silver.

GOLD PLATE TWENTY CARATS FINE.

Formula No. 5.

20 dwts. pure gold,
2 dwts. copper,
2 dwts. silver.

Formula No. 6.

20 dwts. gold coin,
18 grs. copper,
20 + grs. silver.

GOLD PLATE TWENTY-ONE CARATS FINE.

Formula No. 7.

21 dwts. pure gold,
2 dwts. copper,
1 dwt. silver.

Formula No. 8.

20 dwts. gold coin,
13 + grs. silver.

Formula No. 9.

20 dwts. gold coin,
6 grs. copper,
$7\frac{5}{7}$ grs. platinum.

GOLD PLATE TWENTY-TWO CARATS FINE.

Formula No. 10.

22 dwts. pure gold,
1 dwt. fine copper,
18 grs. silver,
6 grs. platinum.

The union of platinum with gold, as in Formula No. 10, furnishes an alloy rich in gold, while it imparts to the plate derived from it a reasonable degree of stiffness and elasticity; preserves in a good degree the characteristic color of fine gold; and does not materially impair its susceptibility of receiving a high polish. The amount of gold coin given in Formula No. 9 may be reduced with platinum alone, adding to it from eight to twelve grains; in which case, although the carat of the alloy is lowered, its absolute purity remains unaffected, and plate formed from it will better resist any changes in the mouth than gold coin itself.

Formulas for Gold Plate used for Clasps, Wire, Stays or Backings, Dowels, etc.—Gold used in the formation of clasps, backings, etc., is improved for these purposes by the addition of sufficient platinum to render it firmer and more elastic than the alloys ordinarily employed in the formation of plate as a base. The advantages of this elastic property, in its application to the purposes under consideration, are, that clasps formed from such alloys will adapt themselves more accurately to the teeth, as, when partially spread apart on being forced over the crowns, they will spring together again and accurately embrace the more contracted portions. In the form of stays or backings, additional strength being imparted, a less amount of substance will be required; the elasticity of these supports, also, will not only lessen the chances

of accident to the teeth themselves in mastication and otherwise, but preserve their proper position when temporarily disturbed by any of the forces applied to them. The same advantages last mentioned are obtained from this property in the use of metallic pivots.

Formula No. 1.	*Formula No. 2.*
20 dwts. pure gold,	20 dwts. coin gold,
2 dwts. fine copper,	8 grs. fine copper,
1 dwt. fine silver,	10 grs. silver,
1 dwt. platinum.	20 grs. platinum.

The alloy derived from either of these formulas will be 20 carats fine.

Gold Solders.—Solders are a class of alloys by means of which the several pieces of the same or of different metals are united to each other. They should be more fusible than the metals to be united, and should consist of such components as possess a strong affinity for the substances to be joined. They should also be as fine as the metals to which they are applied will admit of without endangering the latter. Solders of different degrees of fineness, therefore, should always be provided to make selections from.

The use of solders of doubtful or unknown composition should be avoided, and hence they should be compounded either from pure gold or gold coin.

The following formula taken from Prof. Harris's work on "Dental Surgery," page 666, recipe No. 3, may be used in connection with 18 or 20 carat gold plate, and is 16 carats fine:

6 dwts. pure gold,
2 dwts. rosette copper,
1 dwt. fine silver.

Recipes Nos. 1 and 2, page 663 of same work, are too coarse to be introduced into the mouth; the former being a fraction below 14 carats, while the latter is still more objectionable, exceeding but little 12½ carats.

Formula No. 1 of the following recipes is a fraction over 15 carats fine: and No. 2 furnishes a solder 18 carats fine:

Formula No. 1.	*Formula No. 2.*	
6 dwts. gold coin,	Gold coin,	30 parts,
30 grs. silver,	Silver,	4 "
20 grs. copper,	Copper,	1 part,
10 grs. brass.	Brass,	1 "

In the reduction of gold for solders, Dr. Dorrence recommends the use of what he calls "solder alloy." This is derived from the following formula:

1 part pure silver,
2 parts pure zinc,
3 parts pure copper.

The copper and silver are melted without flux, in a clean crucible which is well lined with borax; the zinc is then added in small quantities as rapidly as may be without chilling the molten mass so that it loses its fluidity, meanwhile stirring it with a clay pipe-stem or rod, or a white-wood stick, until the profuse fumes of the burning zinc just pass off, when pour immediately into an ingot-mold, or into clean water in a clean wooden pail. The metals entering into the composition of this solder alloy should be absolutely pure, especially should they be free of arsenic, antimony, cadmium, etc., in which case not only the alloy, but gold and silver solders made from it, will be tough and easy-flowing. Inasmuch as the zinc, in compounding the alloy, has not been protected from oxidation, if it has been cast at the proper moment, it will be found present in about its combining weight. Both gold and silver solders made with this alloy will, as has been stated, be found very tough, and easy-flowing, the range of proportion most desirable being, for gold solder from 20 to 12 carats, or from 15 to 50 per cent. of alloy. Dr. D. very properly says, however, that the 12 carat or 50 per cent. solder is too coarse for dental work. From 10 to 15 per cent. of the alloy added to gold coin is recommended as a suitable solder in the construction of coin-gold crowns.

Zinc, as a constituent of solders, is used principally with a view of rendering them more fusible without materially debasing them if the proper proportion is observed. Its employment under any circumstances has been objected to by some, on the ground that the alloy is more readily tarnished in the mouth, is more brittle, and that it furnishes more favorable conditions for galvanic action. These objections only hold good when zinc is used in excess. When employed in quantities sufficient only to make the gold flow readily and evenly at a diminished heat, it is claimed that the base metal used in these alloys is chiefly consumed in the process of soldering, leaving a residuum of gold alloy equal, or nearly so, in purity to solder not so contaminated. If such is the case they are

acceptable alloys for soldering purposes, inasmuch as it is not only desirable to have an easy-flowing solder, but one which shall have as little affinity as possible for acids often found associated with the fluids of the mouth. Care should be taken to add no more zinc than is necessary to make the solder flow freely under a heat that may be safely applied, without danger of melting the pieces to be united.

Method of Reducing Gold to a Lower or Raising it to a Higher Standard of Fineness, and of Determining the Carat of any Given Alloy.—In the process of compounding gold for dental purposes, the manipulator should always aim at exactness in the quantity and relative proportions of the reducing components, and should be able to determine precisely the purity of the metals he employs. Gold alloys are too often arbitrarily compounded, and used without any adequate knowledge of their qualities or properties; and formulas, taken on trust, are employed without any certain knowledge of the quality of the alloys they produce.

That we may know certainly the quality of the gold alloys used in the laboratory without resorting to the inconvenient process of analysis or assaying, they should always be made either from pure gold or gold coin, the standard of these being definitely fixed. But as the process of procuring pure gold is somewhat tedious and troublesome, gold coin is very generally employed for the purpose. The amount of alloy necessary to reduce either pure or coin gold to any particular standard, and the method of ascertaining the carat or fineness of any given alloy, may be readily determined by a few simple rules. The following practical remarks on the method are taken from an article on "Alloying of Gold,"* by Professor Watt:

"1. **To Ascertain the Carat of any Given Alloy.**—The proportion may be expressed as follows:

"As the weight of the alloyed mass is to the weight of gold it contains, so is 24 to the standard sought. Take, for example, Harris's No. 3 gold solder:

Pure gold,	6 parts.
" silver,	2 "
" copper,	1 part.
Total,	9 parts.

* *Dental Register of the West,* vol. x, p. 396.

"The total proportion would be expressed thus:

9 : 6 : : 24 : 16.

"From this any one can deduce the following:

"RULE.—Multiply 24 by the weight of gold in the alloyed mass, and divide the product by the weight of the mass; the quotient is the carat sought.

"In the above example, 24 multiplied by 6, the quantity of gold, gives 144, which, divided by 9, the weight of the whole mass, gives 16. Hence, an alloy prepared as above is 16 carats fine.

"As another example, under the same rule, take Harris's No. 1 solder:

22 carat gold,	48	parts.
Silver,	16	"
Copper,	12	"
Total,	76	parts.

"Now, as the gold used is but 22 carats fine, one-twelfth of it is alloy. The $\frac{1}{12}$ of 48 is 4, which subtracted from 48 leaves 44. The statement then is:

76 : 44 : : 24 : 13.9.

"This solder, therefore, falls a fraction below 14 carats.

"2. **To Reduce Gold to a Required Carat.**—The proportion may be expressed as follows:

"As the required carat is to 24, so is the weight of the gold used to the weight of the alloyed mass when reduced. The weight of gold subtracted from this gives the quantity of alloy to be added.

"For example, reduce six ounces of pure gold to 16 carats.

"The statement is expressed thus:

16 : 24 : : 6 : 9.

"Six subtracted from nine leaves three, which is the quantity of alloy to be added. From this is deduced the following:

"RULE.—Multiply 24 by the weight of pure gold used, and divide the product by the required carat. The quotient is the weight of the mass when reduced, from which subtract the weight of the gold used, and the remainder is the weight of alloy to be added.

"As another example under the same rule, reduce one pennyweight of 22 carat gold to 18 carats.

"As the gold is only 22 carats fine, one-twelfth of it is already alloy. The one pennyweight, therefore, contains but 22 grains of pure gold. The statement is, therefore, thus expressed:

$$18 : 24 :: 22 : 29\tfrac{1}{3}.$$

"Twenty-two subtracted from $29\frac{1}{3}$ leaves $7\frac{1}{3}$. Therefore, each pennyweight of 22 carat gold requires $7\frac{1}{3}$ grains of alloy to reduce it to 18 carats.

"3. **To Raise Gold to a Higher Carat.**—This may be done by adding pure gold or a gold alloy finer than that required. The principle of the rule may be set forth in the following general expression:

"As the alloy in the required carat is to the alloy in the given carat, so is the weight of the alloyed gold used to the weight of the reduced alloy required. The principle may be practically applied by the following:

"RULE.—Multiply the weight of the alloyed gold used by the number representing the proportion of alloy in the given carat, and divide the product by that representing the proportion of alloy in the required carat; the quotient is the weight of the mass when reduced to the required carat by adding fine gold:

"To illustrate this, take the following example:

"Raise one pennyweight of 16 carat gold to 18 carats.

"The numbers representing the proportions of alloy in this example are found by respectively subtracting 18 and 16 from 24. The statement is, therefore:

$$6 : 8 :: 1 : 1\tfrac{1}{3},$$

from which it follows that to raise one pennyweight of 16 carat gold to 18 carats, there must be $\frac{1}{3}$ of a pennyweight of pure gold added to it.

"But suppose that, instead of pure gold, we wish to effect the change by adding 22 carat gold. The numbers, then, respectively representing the proportions of the alloy would be found by subtracting, in the above example, 16 and 18 from 22, and the statement would be:

$$4 : 6 :: 1 : 1\tfrac{1}{2}.$$

"It follows, then, that to each pennyweight of 16 carat gold $\frac{1}{2}$ of a pennyweight of 22 carat gold must be added to bring it to 18 carats.

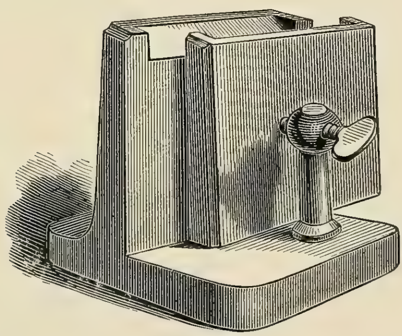
"By the above rules, we think the student will be able, in all cases, to calculate the fineness or quality of his gold, and to effect any reduction, whether ascending or descending, which he may desire."

CHAPTER VI.

METHOD OF CONVERTING GOLD ALLOYS INTO THE REQUIRED FORMS FOR DENTAL PURPOSES.

Manner of Procuring an Ingot.—The gold to be molded in the form of ingot is put into a clean crucible lined on the inside with borax, and placed in the furnace. When the contained metals are perfectly fused, the crucible should be removed from the fire with a pair of tongs, and the contents poured quickly but carefully into the ingot-molds; the latter being placed conveniently near the mouth of the furnace, as the molten metals soon become chilled on exposure to the open air. Before pouring, the molds, if made

Fig. 40.



of iron, should be moderately heated and oiled, or coated with lamp smoke by holding their inner surfaces over the flame of an oil lamp or gas-jet.

Ingot-molds are constructed of various substances, but those in most common use are formed of iron, and, for gold, are generally about two inches square and from $\frac{1}{8}$ to $\frac{1}{6}$ of an inch thick (Fig. 40). They should be slightly concave on their inner surfaces, to compensate for the greater shrinkage of the gold in the center than at the margins of the ingot.

Soapstone is sometimes employed for the same purpose, and is

preferred by some. Molds made from this substance should also be warmed and oiled before pouring the metals.

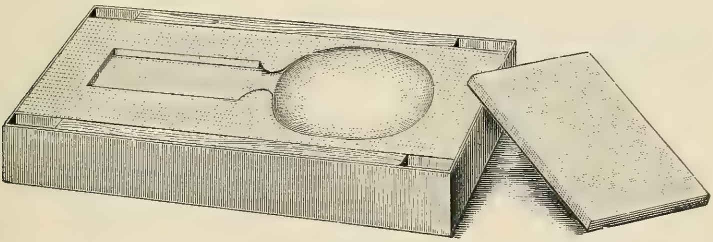
Molds are also made from charcoal, which is highly recommended for the purpose, though it requires to be frequently renewed. Prof. Gorgas, in commenting on the relative fitness or value of the several substances mentioned, says: "Iron is perhaps the most convenient; soapstone gives, with the same gold, a tougher ingot; whilst with charcoal, the greatest toughness of metal is obtained, so far as the nature of the ingot-mold can modify it. Pig-iron, from the same furnace, run into iron molds, may be white and brittle; or into sand molds, gray and less brittle; or into charcoal, dark gray and soft. Some such molecular arrangement of gold, due to its manner of cooling, is probably the correct explanation of the fact that a charcoal mold yields, other things being equal, a tougher ingot than iron."

Charcoal ingot-molds may be very easily and quickly made as follows: Selecting a close-grained compact piece, of suitable size, cut through it with a saw, and then rub the divided surfaces together until perfect coaptation is secured. The required size and shape of the mold is then cut out in one section of the block; or a strip of sheet-iron, a little broader than the required thickness of the ingot, being bent into proper form, is placed between the two pieces, with the edges partially imbedded, and the whole secured in place by binding with wire, or with the use of clamps.

Asbestos Molds.—Comparatively inexpensive, and at the same time more convenient and durable contrivances designed for the same purpose, combining both crucible and mold, and embracing the special advantages claimed for charcoal, may be obtained at the dental depots. One of the simplest forms of this kind is the asbestos melting and ingot block shown in Fig. 41. When in use, place a piece of charcoal over the bowl-shaped portion of the ingot block, as it facilitates heating the metal. The small asbestos slab being placed in position to complete the mold, and retained in place by clamping, the metal, when sufficiently fused, is poured into the mold by tipping the block. The bowl or crucible has a thin coating of whiting, to prevent borax or other flux from adhering. Should this occur, however, rub a little moist whiting in the bowl. The sides of the block are encased in strips of wood, to protect the hands from heat.

Carbon Molds.—A very ingenious, convenient, and useful apparatus, combining crucible and ingot-mold, by the use of which ingots of gold, silver, etc., may be quickly obtained without the use of a furnace, is shown in Fig. 42. The crucible is of molded carbon, and is supported in position by an iron side-plate. A

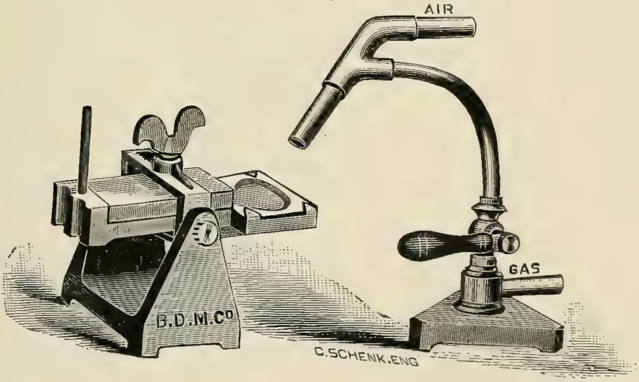
FIG. 41.



clamp holds crucible and ingot-mold in position, swiveling on a cast-iron stand.

The metal to be melted is placed in the crucible, and the flame of the blowpipe directed on it until it is perfectly fused. The waste heat serves to make the ingot-mold hot, and the whole is

FIG. 42.



tilted over by means of the upright handle at the back of the mold. With this simple instrument a sound ingot may be obtained at any time in about two minutes.

Aside from the greater convenience and cleanliness, as compared with the older method in which draft-furnace heat is used,

there is great economy of time in the use of the last-named appliance combining crucible and mold, since an ingot may be thus obtained, with the use of the bellows blowpipe, in from two to three minutes. It is suitable for melting from two to four ounces of gold or silver.

It not infrequently happens that, at the first pouring, the metals arrange themselves in the ingot in accordance with the density of the several components, those of greater specific gravity passing to the bottom, and the lighter metals remaining above. Whenever this occurs, the ingot must be broken into pieces and remelted; this should be repeated, if necessary, until the alloy assumes a perfectly homogeneous appearance. It should then be annealed in hot ashes, which softens the gold and removes the adhering grease.

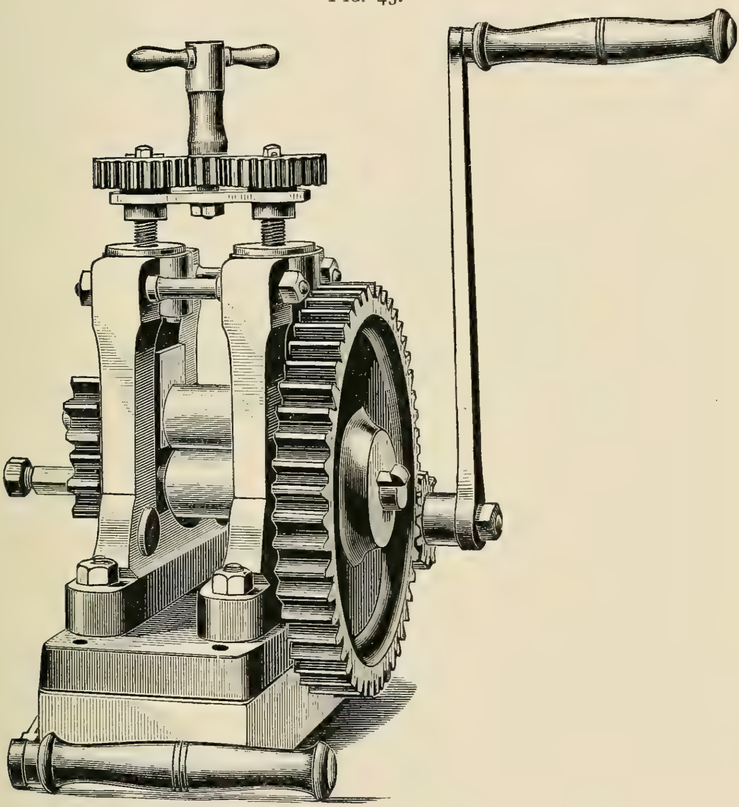
Forging.—Before laminating, the ingot should be reduced somewhat in thickness by placing it on an even-faced anvil or other equally smooth and resistant surface, and subjecting it to repeated blows with a tolerably heavy hammer. It should be frequently annealed, and the process of forging continued, alternately hammering and annealing, until the ingot is reduced one-half or more in thickness.

Laminating or Rolling.—The reduced ingot, well annealed, is next laminated or spread out into a sheet of greater or less thinness by passing it repeatedly between two strong, highly-polished cylindrical steel rollers. The mills used for the purpose are variously constructed, the plainest forms being very simple in their mechanism, while others, or geared mills, are more complicated, and are constructed with a view to a greater augmentation of power, precision, and certainty of action. Fig. 43 illustrates such a mill.

In laminating, the rollers should first be adjusted equidistant at both ends, and this uniformity, as they are approximated from time to time, should be preserved throughout. At every passage of the gold bar between the rollers, the distance between the latter should be diminished, care being taken that the approximation be insufficient to clog or impede the free action of the mills. The gold, which, in time, becomes hard and brittle, and liable to crack in the mills, should be frequently and well annealed by bringing it to a full red heat; this restores the pliancy of the gold and facilitates the operation in the press.

When the ingot has been extended in one direction as far as may be desired, it should always be reannealed before turning it in the mills; a neglect of this precaution will seriously interfere with the working of the gold by twisting or doubling the plate upon itself; and in some instances, provided the gold has not been well annealed throughout the operation, or is in any consid-

FIG. 43.



erable degree unmalleable, the plate will be torn across and rendered unfit for use.

A thin or retreating edge may be given to the plate at any desired point or points by passing such portions part way between the rollers and withdrawing; repeating this, with the rollers brought a little nearer to each other every time the plate is introduced between them, and decreasing the distance the plate

passes each time, until it is reduced to as thin an edge as may be desired.

Standard Gage Plate.—The degree of attenuation obtained by rolling is determined by what is called a *gage plate* (Fig. 44). This instrument is usually circular or oblong in form, and is marked at intervals on its edge by cross-cut grooves, or fissures, which successively diminish in size and are indexed by numbers ranging from 5 to 36. The sizes of the grooves diminish with the ascending numbers. During the operation of rolling, the plate should be tested, from time to time, by the gage, to determine when it has undergone sufficient attenuation.

FIG. 44.

Thickness of Gold Plate Required as a Base for Artificial Dentures.—In prescribing the thickness of plate proper for the purpose indicated, no estimate can be given that will apply to all cases, as certain conditions of the mouth, to be mentioned hereafter, will suggest some modifications in this respect. Usually, however, plate for *entire upper dentures should correspond in thickness with number 26 of the gage plate; for the lower jaw, number 24 may be used;* while for partial upper pieces, an intermediate number may be chosen, unless atmospheric pressure-plates are used, when the number recommended for full upper sets may be employed.

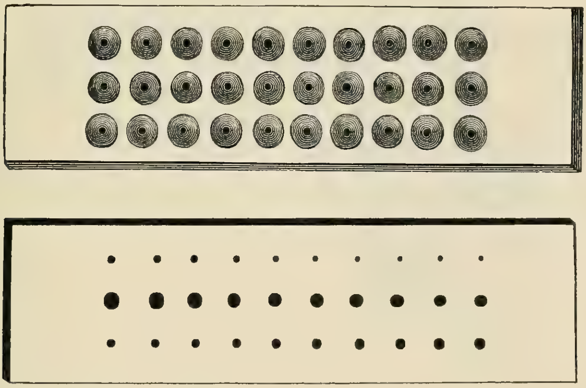
Thickness of Plate for Clasps, Backings, etc.—Plate for these

purposes should usually correspond with number 22 of the gage; a less amount of substance, as before stated, being required when the alloy has incorporated with it a small proportion of platinum.

Reduction of Gold Solders into Proper Form for Use.—The method of converting gold solders into the form of plate does not differ from that already described in the manufacture of plate as a base, except that when zinc or brass is used, the latter should be added after the other constituents are completely fused, and then instantly poured, to prevent undue wasting of the base metals by a too protracted heat.

The solder should be reduced to plate somewhat thinner than that used for upper dentures, 28 of the gage plate. It is customary

Fig. 45.

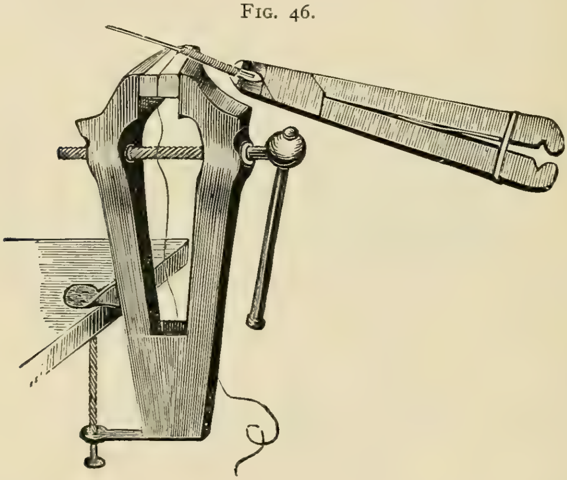


sometimes to roll the solder into very thin ribbons, but this is objectionable for the reason that a greater amount of the alloying metals, being exposed in a given surface to the action of the heat in soldering, are burnt out or oxidated, which interrupts the flow and weakens the attachment between the solder and plate.

Method of Obtaining Gold Wire.—To convert gold or its alloys into the form of wire, the operator should be provided with a draw-plate, a vise, and a pair of flat-nosed pliers. A draw-plate (Fig. 45) is an oblong piece of steel, pierced with a regular gradation of holes, or a series of progressively diminishing apertures, through which the gold bar, reduced to a rod, is forced and made to assume the form and dimensions of the hole through which it

is last drawn. The holes are formed with a steel punch, and are enlarged on the side where the wire enters and diminish with a gradual taper to the other side. A *draw-bench* is sometimes employed in extending the wire, the power being applied by a toothed-wheel, pinion, and rack-work, and is moved by the hands of one or two persons. For the purposes of the dentist, however, it will be sufficient to fix the draw-plate securely between the jaws of a bench-vise, and, by seizing hold of one end of the gold rod with a strong pair of clamps or flat-nosed pliers, serrated or cut like a file on the inside of the jaws, the wire may be drawn stead-

FIG. 46.



ily through the plate, passing from the larger to the smaller holes until a wire of the required size is obtained.

In drawing the wire, the motion should be steady and uniform, for if drawn interruptedly or by jerks, the wire will be marked by corresponding inequalities. The gold rod should also be annealed from time to time, and the holes kept well greased or waxed.

The process described above will answer equally well in reducing any of the ductile metals to wire, as silver, copper, platinum, etc., so that any further description of the method, in connection with these metals, will be unnecessary.

Method of Constructing Spiral Springs.—Inasmuch as spiral springs have been, to a great extent, superseded by more approved agencies employed in the retention of artificial teeth in

the mouth, and as all the principal dental furnishing houses are supplied with these appliances already prepared for use, it does not seem necessary to enter into a description of the various apparatus used in making them.

The following simple contrivance will meet the limited requirements of those who are obliged or prefer to manufacture their own springs. The wire, obtained as already described, by means of the draw-plate, is held between two blocks of wood fastened between the jaws of a bench-vise, as shown in Fig. 46. By means of a small hand-vise, one end of the wire is clamped to a uniformly cylindrical and well-tempered steel rod or wire, four or six inches long, and about the size of a small knitting-needle, and which being made to revolve while resting on the blocks of wood, the wire is wound firmly and compactly around it, producing a uniform coil.

CHAPTER VII.

SILVER.

Ag (Argentum).

General Properties of Silver.—Pure silver, when planished, is the brightest of the metals. Fused, or in the form of ingot, its specific gravity is 10.47; but when hammered or condensed in the coining press, its density is increased and its specific gravity becomes 10.6. It is very malleable and ductile, yielding leaves not more than $\frac{1}{100000}$ of an inch thick, and wire 400 feet of which may be drawn weighing but a single grain. It exceeds gold in tenacity or cohesion, but is inferior to platinum in this respect. A silver wire .078 of an inch in diameter will sustain a weight of 187.13 pounds. Fine silver is unaffected by moisture or pure atmospheric air, but is readily tarnished with a film of brown sulphuret by exposure to sulphureted hydrogen. The sulphuret of silver thus formed may be easily removed by rubbing the metal with a solution of *chameleon mineral,* prepared by calcining equal parts of black or peroxid of manganese and niter. *Unlike gold and platinum, it is readily soluble in nitric acid, this and sulphuric acid being the only simple ones that dissolve it.*

Silver fuses at an extreme red heat, generally estimated at 1873° F. It becomes very brilliant when heated; boils and vaporizes above its fusing-point; and when cooled slowly its surface presents a crystalline appearance.

Alloys of Silver.—Silver combines readily with most metals, forming compounds of variable degrees of malleability, ductility, density, etc.

Tin, zinc, antimony, lead, bismuth, and arsenic render it brittle. A very minute quantity of tin is fatal to the ductility of silver. Silver does not easily combine with iron, although the two metals may be united by fusion. Gold, copper, platinum, iridium, steel, manganese, and mercury also form alloys with silver.

An alloy of nine parts of silver and one part of copper is the

Government standard of the United States coinage since 1837. To this, three-cent pieces form an exception; these being composed of three parts silver and two of copper. The coins of silver having a greater average fineness than those of our own country are Brazil, Britain, Chili, France, Greece, Hindustan, Persia, Portugal, Rome, and Tuscany. A common impression prevails that the Mexican silver coin contains more than an average percentage of pure silver, and it is therefore sought after on account of its supposed purity. This is true of some pieces coined at different periods, but the average fineness of the Mexican, as well as the Spanish coins, falls below that of the United States mints.

Refining Alloys of Silver.—The following accounts of the manner of obtaining pure, or nearly pure, silver from alloys of that metal by the dry, and wet or humid methods, are given by Prof. Essig in his treatise on "Dental Metallurgy:"

"**Dry Method.**—The dry method or assaying process consists in forming an alloy of the silver with lead, and is especially applicable to ores and the sweepings of the dentist's laboratory. The specimen to be treated is heated with from twelve to thirty times its weight of granulated lead, in a bone-ash cupel, which is placed in a muffle so arranged that a current of atmospheric air may pass freely over the vessel and oxidize the lead. This oxid of lead, being quite fusible, combines with any base metal present and oxidizes it, uniting subsequently with the oxid as a fusible slag, while the gold or silver will be held by the unoxidized portion of the lead. In the treatment of specimens of alloy, such as plate or coins, a quantity of the specimen is accurately weighed and mixed with from four to five times its weight of pure granulated lead. It is then placed in the cupel and exposed to heat, as above described, until all the lead is oxidized or converted into litharge, when the remaining button assumes the brilliant apearance of surface to which allusion has been previously made, denoting that the base metals or oxidizable constituents have been oxidized and taken up by the lead oxid. This button is then to be weighed by means of a delicate assay balance, and the loss of weight denotes the amount of alloy that was present.

"**Wet Method.**—Pure silver, which is reckoned as 1000 fine, may be obtained from standard or other grades of silver by dissolving them in nitric acid slightly diluted with water, the solution

being much facilitated by exposure to gentle heat. If gold be associated with the alloy it will be found at the bottom of the vessel, in which case it will be necessary to use a siphon to remove the argentic nitrate solution. The silver is now to be precipitated in the form of chlorid by the addition of an excess of common salt. When all has subsided, the liquid is carefully poured off, and the chlorid thoroughly washed, to remove all traces of acid. The chlorid is then placed in water acidulated with hydrochloric acid (an ounce of chlorid requiring six to eight ounces of water) and pieces of clean wrought-iron put in it, when a copious evolution of hydrogen follows, which, uniting with the chlorin of the argentic chlorid, liberates metallic silver. The latter should not be disturbed until the last particle of it is thus reduced, when it will be found to be a spongy mass. The undissolved iron should now be carefully removed, the ferrous and ferric chlorid carefully decanted, and the silver washed in hot water containing about one-tenth its bulk of hydrochloric acid. This is repeated several times, and finally the silver is again thoroughly washed with pure hot water. The silver, after drying, is then ready for melting, and if care has been observed in the process it will be found to be of a fineness of 999.7 parts in 1000, the 0.3 of impurity present being due to traces of iron. The chlorids may be acidulated with sulphuric acid, and reduced with zinc instead of iron.

"**Another method** of precipitating silver in the metallic form consists in placing a sheet of copper in a solution of argentic nitrate. The metal is thrown down in a crystalline form. Silver thus obtained is never free from traces of copper.

"Pure silver can only be obtained from samples of a lower grade by fusing the pure chlorid with sodium carbonate. The reaction is shown in the following equation:

$$2AgCl + Na_2CO_3 = Ag_2 + 2NaCl + O + CO_2.$$

Owing to the copious evolution of carbonic acid gas which takes place during the decomposition, some of the silver may be thrown from the crucible, and loss may occur by the absorption by the crucible of some of the fused chlorid. To avoid this, the sides of the vessel should be coated with a hot saturated solution of borax.

"A composition of 100 parts of argentic chlorid, 70.4 of calcic

carbonate (chalk), and 4.02 of charcoal, has been recommended as a means of obtaining pure silver. This mixture is heated to dull redness for thirty minutes, and then raised to full redness; carbonic acid and carbonic oxid are given off; the calcic chlorid is converted into calcic oxychlorid, underneath which, in the bottom of the crucible, will be found the button of pure silver."

Reduction of Silver to the Required Forms for Dental Purposes.—Owing to the very soft and flexible nature of silver in its pure state, it is usual, when converting it into plate or other forms for use, to employ an alloy of the metal. Hence silver coins, which are made harder by the copper they contain, are generally selected for the purpose. The employment of silver, thus debased, as a base for dental substitutes is regarded by many as unsafe and injudicious. Although the influences of an alloy so readily acted upon as this by the various agents which affect it chemically cannot always be certainly predicted in every case, yet no reasonable doubt can be entertained but that, under the favoring conditions which usually exist in the mouth, the evils accruing, directly and indirectly, to the organs of the mouth, and through them to the general system, are positive and undoubted. If used at all, therefore, it should be alloyed with the least practicable amount of copper, or, what is better, pure silver should be reduced with platinum alone, in sufficient quantities to impart to the plate an adequate degree of strength and elasticity. The tendency of silver to tarnish in the mouth when alloyed with copper may be diminished by boiling the finished piece in a solution of cream of tartar and chlorid of soda, or common salt, or by scrubbing it with aqua ammonia, which removes the superficial particles of copper and exposes a surface of fine silver. When platinum is introduced as the sole alloying component, the purity of the silver is not only preserved, but the alloy is less easily acted on chemically, while the plate derived from it is rendered sufficiently inflexible and elastic. From three to five grains of platinum may be added to one pennyweight of pure silver.

On account of the strong affinity of sulphur for silver, the fuel most proper to be used in melting it is charcoal. The various processes employed in the conversion of silver into the required forms for use are similar to those described for gold, and need not be recapitulated.

Formulas for Silver Solders.—Silver solders are usually composed of silver, copper, and zinc in variable proportions. Alloys formed from the following formulas are such as are generally employed in soldering silver plate, derived from the coins of that metal. Three-cent pieces, composed of two parts silver and one of copper, may be used for the same purpose:

Formula No. 1.			*Formula No. 2.*		
Silver, ...	66	parts.	Silver, ...	6	parts.
Copper, ...	30	"	Copper, ...	2	"
Zinc, ...	10	"	Brass, ...	1	part.

When the material to be united is composed of pure silver and platinum, silver coin alloyed with one-tenth zinc may be used as a solder.

In compounding silver solders the silver and copper should be first melted, and the zinc or brass afterward added, when they should be quickly poured, to prevent undue waste by oxidation of the more fusible component. The ingot, when cold, should be rolled into a plate a little thicker than that recommended for gold solder.

CHAPTER VIII.

PLATINUM.

Pt.

General Properties.—Platinum is a grayish-white metal, resembling, in some measure, polished steel. It is harder than silver, and has a density greater than any other known metal, its specific gravity being 21.25. It remains unaltered in the highest heat of a smith's forge, and can only be fused by means of the oxyhydrogen blowpipe and galvanism. A white heat does not tarnish it, nor is it in any way affected by exposure, either in the air or water. It is insoluble in any of the simple acids; *nitro-muriatic acid* (aqua regia) *being the only one that dissolves it.* It is sufficiently malleable to be hammered into leaves so thin as to be blown about by the breath. It may be drawn into wire $\frac{2}{1000}$ of an inch in diameter, and a still greater attenuation may be obtained by coating the wire with silver, drawing it out, and dissolving off the latter metal. It expands less by heat than any other metal, and is much inferior to gold, silver, and copper as a conductor of electricity. While it does not oxidize in the air at any temperature, nor is soluble in any one acid, if heated to redness in the air, in contact with caustic alkalies or alkaline earths, a hydrated oxid is formed which combines with the alkaline base in a similar manner to palladium.

Platinum, when absolutely pure, is quite soft and flexible, and when rolled into thin sheets, say 28 or 30 of the gage plate, and well annealed *at a strong white heat for eight or ten minutes,* it may be readily forced into all the inequalities of a zinc die without producing any appreciable change in the face of the latter.

The fusing-point of platinum is above 3500° F., to reach which, in the laboratory, it is necessary to employ the oxyhydrogen blowpipe or electric current.

The following interesting and practical observations on the method of melting platinum scraps are by E. A. L. Roberts.

By the process of welding, the operator will be enabled to reconvert his waste scraps of platinum into convenient forms for use, and of which he could not otherwise avail himself, on account of the infusible nature of this metal in its uncombined state:

"Platinum used by dentists should be soft, tough, and without flaws. These qualities can be attained only by thorough melting and welding. The welding must be done at a white heat. When the surface is cool enough to be visible, the metal is too cool to be welded, and every blow is injurious, because it has a tendency to shatter and shake it to pieces. The necessary delicacy of this process and the uncertainty of success has led some writers to declare that platinum is incapable of being welded. The platinum must be perfectly clean, and must be heated in a muffle. When welded, the metal should be handled with tongs plated with platinum, and hammered with a clean hammer on a clean anvil, both of which should be as hot as possible without drawing the temper of the steel. The hammer used in welding should weigh about a pound, to prevent drawing the metal; but when welded the metal may be forged with a heavier hammer.

"The scraps or sponge should be condensed in a square mold, very compactly, two pieces of which, weighing from 10 to 20 ounces, may be put in a muffle together. When the heat becomes so great that on opening the door the metal becomes invisible, bring one of the pieces, in the tongs, quickly to the anvil, give it three or four quick, sharp blows, in rapid succession. Return the piece to the muffle, and proceed with the other piece in like manner, and thus alternately until both are thoroughly welded.

"Platinum should never be thrown into water while hot, as that tends to make it crystallize. It should be thoroughly hammered, which makes it tough and fibrous.

"The following process gives the best results in melting this metal. Condense the scraps, sponge, or filings in an iron mold. Lay the condensed mass on a concave fire-brick, and heat it to whiteness. Take the brick from the muffle, and place it in a sheet-iron pan, coated with plaster and asbestos. The pan should be deep enough and broad enough to catch all globules and other loose particles of the metal. Place it under the jet of the oxyhydrogen blowpipe in the following manner:

"The pan is provided with a handle, opposite to which is a ring,

which is to be attached to an iron hook and rod, suspended from the ceiling by a slip of india-rubber, which enables the operator to hold the pan conveniently at any distance from the jet of the burning gases. The hydrogen is first lighted, and gives a powerful flame, but as the oxygen combines with it, the flame subsides into an intense focus of heat, in which the metal is soon brought to a state of fusion. Begin at one end and melt along toward the other, till the whole is fused in one mass. The platinum in this condition, when cool, is quite crystallized and sonorous. It breaks very easily, like spelter-zinc. Heat it very hot and forge it. A continuation of this process renders it soft, tough, and fibrous. When reduced to the width desired, and to the thickness of ¼ of an inch, it should be made very hot and passed instantly through the rollers."

Use for Dental Purposes.—Platinum, in mechanical practice, is chiefly employed as a base for continuous-gum work; as a coloring ingredient of porcelain; for pins for attaching mineral teeth; for backings and dowels in crown- and bridge-work; and, to a limited extent, in some of the minor operations of the laboratory.

Solder for Platinum.—Pure gold is the only proper solder for this metal.

Alloys of Platinum.—Platinum unites with most of the base metals, forming alloys of variable degrees of hardness, elasticity, brittleness, color, fusibility, etc., but their practical value to the dentist is not sufficient to justify a separate description of their properties.

Alloyed with *gold* it forms a straw-colored alloy, the shade depending on the quantity of gold added. *Silver* hardens it, the resulting alloy being unaffected by sulphur.

Platinoid Metals.—The platinoid metals, palladium, iridium, osmium, rhodium, and ruthenium, are native contaminations, the alloys of these metals having a close general resemblance to platinum.

Among the platinoid metals, palladium and iridium are the only ones that have been used for dental purposes, and these only to a limited extent. Palladium is of a steel-gray color, and when planished, is a brilliant steel-white metal, not liable to tarnish in the air. Though closely resembling platinum, it may be readily distinguished from the latter metal by the following tests: (1) It

has little more than one-half the density of platinum. (2) If a piece of it is heated to redness, it assumes a bronze-blue shade, of greater or less intensity, as it is cooled more or less slowly; but if it is suddenly chilled by immersing it in cold water, it instantly resumes its original luster. (3) When a drop of the tincture of iodin is let fall upon its surface and evaporated over the flame of a lamp, a black spot remains, which does not occur with platinum. Palladium melts at about the heat required to fuse malleable iron, and is the most fusible of the platinoid metals. It is soluble in nitric acid, but its best solvent is nitrohydrochloric acid.

Palladium, being very costly, and possessing no properties that specially recommend it for dental use, is but little employed in prosthetic practice.

Iridium, though generally found associated with platinum, osmium, and other allied metals, sometimes occurs native and nearly pure. Like platinum, it is very refractory when exposed to high temperatures, and can only be fused by the oxyhydrogen blowpipe or by the heat of the voltaic current. An alloy of one-fifth platinum and four-fifths iridium has been met with in octahedral crystals, whiter than platinum, and of specific gravity 22.66. When native platinum is dissolved in nitrohydrochloric acid, black scales remain behind, which are composed of iridium and osmium. These metals may then be separated by one of the methods in use, and the iridium is obtained in a gray metallic powder, resembling spongy platinum. Iridium is very hard, white, and brittle, and has a specific gravity of 21.15. None of the acids attack the pure metal, but when alloyed with platinum it is readily dissolved by aqua regia or nitrohydrochloric acid. If heated in a finely divided state in the open air, iridium absorbs oxygen; it is also oxidized by niter and caustic potash.

The extreme hardness and consequent rigidity of iridium renders it, in its unalloyed state, practically unfit for base plates on account of the great difficulty of swaging it into proper form. This, however, may be accomplished in certain cases, as in partial pieces, with the use of zinc dies and counters; and in these cases it is desirable on account of the increased strength its property of hardness imparts to the plate. It may be used to advantage, however, alloyed with platinum, a small quantity imparting to the latter increased stiffness and elasticity.

CHAPTER IX.

ALUMINIUM.

Al.

Derivation.—Aluminium is the metallic basis of alumina, the latter being the characteristic ingredient of common clay. It is only within a comparatively few years that the attention of chemists has been directed to the production of this metal, with a view to its general introduction into commerce and the arts. Prior to the researches of M. Deville, who, under the patronage of the then Emperor of the French, commenced his researches in 1854 for the production of this metal on a large scale, the small quantities produced, and the corresponding exorbitant prices it commanded, rendered it entirely unavailable for other purposes than merely scientific experiment. The improvements in the methods of obtaining it, however, which have been more recently introduced, have rendered its production more economical, and it is now supplied in much larger quantities, and at a corresponding reduction in the cost of the metal. The latest process for extracting aluminium is by the electric current. The Pittsburg Reduction Company, especially, is using this method with much success.

General Properties.—One of the most striking properties of aluminium is its extreme lightness, its specific gravity being 2.6, nearly that of glass, whilst that of platinum is 21.5, gold 19.5, copper 8.96, zinc 7.2, tin 7.3.

The metal is very malleable and ductile; that is, it can be reduced to thin sheets or drawn into very fine threads. Its tenacity, though superior to that of silver, is less than that of copper; but no very accurate experiments have been made in this respect.

When pure it is about as hard as silver, and is about the color of new zinc. Its elasticity is not great. It files readily, and is said not to injure the file. It conducts electricity with great facility, so that it may be considered as one of the best conductors

known, almost equal in this respect to silver, and more than eight times a better conductor than iron.

Fusing-point.—Aluminium melts at about 1160° F. (according to the latest experiments), between zinc and silver. In its chemical qualities it would seem to take an intermediate rank between what are termed the noble metals and the common metals, being, as Deville states, one of the most unalterable of metals.

Corrodibility.—One of the most marked qualities of aluminium is its resistance to oxidation. It might be imagined that it would as readily reassume its oxygen as it parted with it with difficulty when in its state of oxid. This, however, is not the case; it appears to be as indifferent to oxygen as either platinum or gold. In air and in oxygen it undergoes no sensible alteration, and it even resists it at the highest temperature which Deville could produce in a cupelling furnace, a temperature higher than that employed in assaying gold. Water has no action, according to Deville, on aluminium, either at its ordinary temperature, when boiling, nor even upon the metal at a low, red heat, near its melting-point. According to Professor Crace Calvert, this statement must be received with some degree of caution, as in experiments he has made he considers that oxidation does take place slowly when the metal is immersed in water for any considerable length of time. It is not, however, affected by sulphur or sulphureted hydrogen.

Solubility.—Aluminium is not acted upon to any considerable degree by any of the oxyacids in the cold; nitric acid, whether strong or weak, at its ordinary temperature, in no way affects it, though when boiling it acts upon it slowly. Small grains of aluminium, plunged in sulphuric acid for three months, remained apparently unaltered. The vegetable acids, such as acetic, oxalic, and tartaric acids, have scarcely any effect on it at all. *The true solvent of the metal is hydrochloric acid,* which attacks it rapidly. It appears to resemble tin when brought into contact with hydrochloric acid and the chlorids. Its absolute harmlessness permits of its being employed in a vast number of cases where the use of tin would not be desirable on account of the extreme facility with which that metal is dissolved in the organic acids.

Manner of Annealing.—For the purpose of annealing aluminium the surface of the plate may be coated with oil, and then

passed over the flame of a spirit-lamp or Bunsen burner until the oil is entirely burned off and the plate becomes white, when it is instantly withdrawn. Or it may be accomplished by placing the piece of plate in a furnace muffle, an even heat being maintained until the metal is hot enough to char the end of a pine stick, which should leave a black mark behind it as it is drawn over the plate. The metal on being withdrawn should be allowed to cool slowly.

Manner of Melting.—Aluminium should be melted in ordinary plumbago crucibles, as it does not absorb or unite with carbon when heating in contact with it. No flux is needed to cover the molten metal, as it is non-volatile at any temperature that can be obtained with an ordinary furnace.

Casting.—Aluminium is now being used to considerable extent in castings of all descriptions where lightness, non-corrodibility, and silvery color is desired. Either iron, sand, or plaster and marble-dust molds can be used, the metal being poured as cold as possible.

Polishing.—The truly distinctive and beautiful color of aluminium is best brought out in highly polished plate. To polish, use rouge or tripoli; or "Almeta Polish," which was introduced by the Pittsburg Reduction Co., has earned a well-merited reputation as an aluminium polish. Its formula is as follows:

Stearic Acid,	1 part.
Fuller's Earth,	1 "
Rotten Stone,	6 parts.

The whole ground very fine and well mixed.

On flat surfaces the highest finish can be given with fine emery paper and oil.

Soldering.—Several methods of soldering aluminium have proven more or less successful for some purposes; one of the solders is 6 parts aluminium, 4 copper, and 90 zinc, another, recommended by Schlosser, is 30 parts gold, 1 platinum, 20 silver, 100 aluminium; none of them, however, is suitable for attaching artificial teeth to be worn in the mouth. The only way in which the metal has been successfully employed as a dental base is with the rubber attachment.

Alloys.—Aluminium, like iron, does not unite with mercury, and scarcely at all with lead. It, however, forms a variety of alloys with other metals. It can be alloyed with iron, and seems

to unite readily with zinc; a variety of alloys with nickel have been made, and that consisting of 100 parts of aluminium and three of nickel is found to work readily, and to have gained hardness and rigidity, as compared with the pure metal. The alloys, however, with copper are the most striking; they are light and very hard, and capable of a fine polish. In the same degree that copper adds to the hardness of aluminium, so does the latter, when used in small quantities, give hardness to copper, without, however, injuring its malleability. It renders it susceptible of a fine polish, and, according as the proportions are varied, the color of the alloy becomes deep or pale gold. Alloys of copper with five and ten per cent. of aluminium resemble gold, perhaps, more than any other metallic alloy hitherto employed. They do not tarnish sensibly by exposure to the air. Aluminium can be deposited by the battery, and by the same agent it can be gilt or silvered.

Dental Uses.—For several years past attempts have been made to render aluminium available as a base for artificial dentures, both by the swaging and casting processes, with only partial success. When in the form of plate no suitable solder has yet been discovered by which the several parts of a dental appliance may be securely united, and experiments in casting have not yet proven entirely satisfactory. It is being used to a limited extent, with rubber attachment, and it is hoped that in the near future, upon further acquaintance with its capabilities, it may prove entirely acceptable for dental purposes.

CHAPTER X.

COPPER, ZINC, LEAD, TIN, ANTIMONY, AND BISMUTH.

COPPER.

Cu (Cuprum).

General Properties.—Copper is one of the metals most anciently known; it is of a brownish-red color, with a tinge of yellow; has a faint but nauseous and disagreeable taste, and imparts, when exposed to friction, a smell somewhat similar to its taste. Its specific gravity ranges from 8.8 to 8.9. It is both malleable and ductile, but excels in the former property, finer leaves being obtained from it than wire. It is inferior to iron in tenacity, but surpasses gold, silver, and platinum in this respect. **The fusing-point** of copper is about 2000° F.

Alloys of Copper.—Copper unites readily with most metals, forming alloys of great practical value in the arts, but which have but a limited application in dental laboratory processes. Many of these alloys are curious and instructive, as illustrating the singular and unaccountable influence of alloying upon the distinctive properties of the component metals. Copper and tin, for example—the former of which is highly ductile, and the latter equally malleable—when combined in the proportion to form speculum metal (9 C : 1 T), form an alloy distinguished for its extreme brittleness, with a surface hardness almost equal to steel. By increasing the quantity of tin until the compound assumes the proportions constituting gun-metal (C 2 : T 1), the alloy, though neither malleable nor ductile, becomes eminently tough and rigid. Other prominent examples might be given, showing how completely this combining influence defies all calculations in regard to ultimate results. The following summary embraces the names and composition of the more familiar alloys of copper, omitting, as unnecessary in this connection, a description of their individual properties.

Alloys of Copper with Zinc.—*Brass* is an alloy of uncertain

and variable composition, consisting usually, however, of two to five parts of copper and one of zinc. Brass melts at 1869° F. *Prince's metal,* and its allied compounds, *Pinchbeck, Similor,* and *Mannheim gold,* consists of nearly equal parts of copper and zinc. *Mosaic gold,* consists of 100 parts of copper and from 52 to 55 of zinc. *Dutch gold,* from which foil of that name was formerly obtained, is formed of 11 parts of copper with two of zinc. *Bath metal* is composed of 32 parts of brass and nine of zinc.

Brass solder consists of two parts of brass and one of zinc, to which a little tin is occasionally added.

Alloys of Copper with Tin.—*Bell metal* usually consists of 100 parts of copper with from 60 to 63 parts of tin. *Cannon metal* is compounded of 90 parts of copper with ten of tin. *Cymbals* and *gongs* contain 100 parts of copper and 25 of tin. *Speculum metal* consists of two parts of copper and one of tin.

Copper and arsenic form a white-colored alloy, which, in the proportion of nine parts of copper and one of arsenic, is white, slightly ductile, and is denser and more fusible than copper.

German silver is composed of copper, 40.4; nickel, 31.6; zinc, 25.4; iron, 2.6; but the proportions of the metals of this alloy differ according to the various uses to which this compound is applied.

Babbitt metal is a compound of copper, antimony, and tin, in somewhat varying proportions. The following formula is given by Henry Long Jacob in the *British Journal of Dental Science:*

Copper,	2	parts.
Antimony,	3	"
Tin,	12	"

The following method of preparing it is given by the same writer:

"In preparing this metal, the copper is first melted in a crucible, with about an equal weight of tin (the copper thus fusing much more readily than by itself), a little more of the tin is then added, next the antimony, and lastly the remainder of the tin by degrees, stirring well during the whole of the time; the metal can then be poured into sand molds of any convenient form. About a year and a half ago I furnished Mr. Thomas Fletcher with this formula, and I believe it is given in his work on 'Dental Metal-

lurgy.' The melting-point of this metal is lower than that of zinc and somewhat higher than that of lead, so that counter-molds of this latter can be readily made to it with proper care. I am under the impression that the original Babbitt metal was said to contain a portion of lead, but this addition was found to be injurious."

ZINC.

Zn (Zincum).

General Properties.—Zinc is a bluish-white metal, possessing considerable luster when broken. The commercial variety is always impure, containing traces of iron, lead, cadmium, arsenic, carbon, etc. It does not easily tarnish in dry air, but soon becomes dull on exposure to moisture. In the condition in which it ordinarily occurs it is a brittle metal, but may be rendered malleable by annealing it at certain temperatures. This change in its condition is effected by subjecting it to a heat of from 220° to 300° F., at which temperature it may be rolled into sheets, and retain its malleability when cold. The best annealing temperature for zinc is about 245° F. A knowledge of this fact will enable the operator to avail himself of the advantages of this property by annealing his zinc die, by which its liability to crack or part under the hammer is diminished.

The fusing-point of zinc is about 775° F., and when heated much above this point in contact with air, it burns with a brilliant, greenish-white flame, while woolly-looking flocculi rise from the vessel in which it is being heated and float in the air. The specific gravity of zinc varies from 6.9 to 7.2.

Use for Dental Purposes.—Zinc has been long, and almost exclusively, employed in the formation of dies used in swaging metallic plates employed in mounting artificial teeth, and experience has very justly accorded to it undisputed preëminence above all other unalloyed metals for the purpose. A more particular account of its peculiar fitness for dental purposes will be given under the head of Metallic Dies and Counter-Dies.

LEAD.

Pb (Plumbum).

Properties.—Lead has a grayish-blue color, with a bright metallic luster when melted or newly cut, but it soon becomes tarnished and dull-colored when exposed to the air. The specific gravity of commercial lead, which is usually contaminated with other metals, is 11.352.

The fusing-point of lead is 617° F. Exposed to a high heat, it absorbs oxygen rapidly, forming on its surface a gray film of protoxid and metallic lead. It is both malleable and ductile, but soft and perfectly inelastic.

Its Use in the Laboratory.—Lead, either in its pure state or when alloyed with certain other metals, serves important purposes in the dental laboratory. In its simple or uncombined state it is useful only in forming counter-dies. Alloyed with antimony in the proportion of ¼ to ⅛ of the latter, with the addition sometimes of very small portions of copper, tin, and bismuth, it forms different grades of *type-metal,* which is harder than lead and very brittle, and is sometimes used for dies; and sometimes, though very rarely, for counter-dies. When type-metal is used as a counter to a zinc die, it is improved for the purpose by adding to it an equal quantity of lead; it may also be used in the form of a die in connection with a lead counter after rough stamping with zinc.

Fusible Alloys.—The alloy known as Rose's *fusible metal* is composed of two parts of bismuth to one of lead and one of tin, and melts at about 200° F. A still more fusible alloy is composed of lead three parts, tin two parts, and bismuth five parts, which fuses at 197°. There are other alloys of lead, to be mentioned hereafter, melting at from 200° to 440°, which may be advantageously employed in forming dies to be used after zinc, where the latter, from its greater shrinkage, fails to bring the plate into accurate adaptation to the mouth.

Soft solder is an alloy composed of lead and tin in the proportion of two parts of the former to one of the latter.

TIN.

Sn (Stannum).

Properties.—Tin is a brilliant, silver-white metal, the luster of which is not sensibly affected by exposure to the air, but is easily oxidized by heat. It has a slightly disagreeable taste, and emits, when rubbed, a peculiar odor. It is soft, inelastic, and, when bent, emits a peculiar cracking sound called the *creaking of tin*. It is inferior in tenacity and ductility, but is very malleable, and may be beaten into leaves $\frac{1}{2000}$ of an inch in thickness, ordinary *tin foil* being about $\frac{1}{1000}$ of an inch thick.

The fusing-point of tin is about 450° F.; it boils at a white heat, and burns with a blue flame to binoxid.

The more common alloys of tin with other metals have already been noticed. It was at one time used as a base for artificial teeth, and more recently it has been introduced as a component of "cheoplastic" metal, a compound used for the same purpose. In its pure state, it is sometimes used for counter-dies, and occasionally for dies. When employed for the latter purpose in connection with a lead counter, the latter should not be obtained directly from the die, as the high temperature of melted lead would produce, when poured upon the tin, partial fusion of the latter and consequent adhesion of the two pieces. Tin is also used by many operators as a trial base-plate for artificial dentures, instead of wax, gutta-percha, or other more pliable materials.

ANTIMONY.

Sb (Stibium).

General Properties.—Antimony is of a silver-white color, with a tinge of blue, a lamellar texture, and a crystalline fracture. It is brittle and easily pulverized. It enters as an ingredient into the composition of type- and stereotype-metal, music plates, and Britannia metal. It is also a component of certain fusible alloys analogous to those already mentioned under the head of lead, and which, in the form of a die, are sometimes used on account of their slight degree of shrinkage.

The fusing-point of antimony is 840° F., and when heated at the blowpipe it melts with great readiness, and diffuses white

vapors, emitting an odor similar to garlic. The specific gravity of the purest variety is 6.715.

BISMUTH.

Bi (Bismuthum).

General Properties.—Bismuth is a white-colored metal, resembling, in some degree, antimony. It is soft, but so brittle as to be easily pulverized. Its specific gravity is 9.83, which may be increased somewhat by hammering.

The fusing-point of bismuth is about 510° F. When the temperature of the metal is raised from 32° to 212° it expands $\frac{1}{120}$ in length.

Alloyed with Other Metals.—Bismuth has the property, in a high degree, of increasing the fusibility of the metals with which it is incorporated, and is a common ingredient of the more fusible alloys, some of which melt in boiling water. One part of bismuth with 24 of tin is malleable, but the alloy of these metals becomes brittle by the addition of more bismuth. Bismuth unites readily with antimony, and in the proportion of one part or more of the former to two of the latter, it expands in the act of cooling.

There are many other metals and alloys beside those already enumerated, but which have not been particularly described on account of their inutility in the laboratory for dental purposes. Among these may be mentioned *iron, brass, bronze*, etc., which are only employed for auxiliary purposes, and are both inconvenient and impracticable for dies by reason of their infusible nature and consequent contraction; *nickel,* on account, also, of its extreme infusibility and its tendency to render the alloy of which it is a component less fusible; *sodium,* on account of the changes produced on it by exposure to the air; *potassium,* on account of its extreme sensitiveness to the influence of low temperatures, being semi-fluid at 60° F., nearly liquid at 92°, and entirely so at 120°; *arsenic,* because it volatilizes before fusing; *cadmium,* with no advantages above tin, on account of its scarcity, costliness, etc.

CHAPTER XI.

GENERAL PROPERTIES OF ALLOYS, AND THEIR TREATMENT AND BEHAVIOR IN THE PROCESS OF COMPOUNDING.

All alloys possess metallic luster, are opaque, conduct heat and electricity, and, in a greater or less degree, are ductile, malleable, elastic, and sonorous. Some alloys, as brass and gong metal, are usually malleable in the cold and brittle when hot.

Metals sometimes unite in atomic ratios, forming compounds of definite or equivalent proportions of the component metals, as certain alloys of copper and zinc, gold and copper, gold and silver, mercurial alloys, etc., while, on the other hand. many are formed in all proportions, like mixtures of salt and water.

Metals differ in respect to their affinity for each other, and do not, therefore, alloy with equal facility; thus it is difficult to unite silver and iron, but the former combines readily with gold, copper, or lead.

The ductility of an alloy is, in general, less than that of its constituent metals, and this difference is, in some instances, remarkably prominent, as in the case of certain alloys of copper and tin, already mentioned.

An alloy is generally harder than the mean hardness of its components, a property which, when taken in connection with their increased fusibility, gives to alloys peculiar value in the formation of dies for stamping purposes. To the rule stated, amalgams, or mercurial alloys, are cited as exceptions.

The density of an alloy varies with the peculiar metals composing it, being generally either greater or less than the mean density of its several components.

It is impossible to predict with certainty the melting-point of an alloy from that of its separate constituents, but, generally, the fusibility of the alloy is increased, sometimes in a most remarkable degree. The alloy of five parts of bismuth, three of lead, and two of tin is a striking example of this fact, this compound melting at 197°, while the mean melting-point of its constituents

is 514°. Silver solder is also a familiar illustration of the influence of alloying on the fusibility of metals; copper, melting at 1996°, and silver at 1873°, when combined fuse at a heat much below that required to melt silver, the more fusible component of the alloy. Again, iron, which melts at a little less than 3000°, acquires almost the fusibility of gold when alloyed with the latter. Examples might be multiplied, but it will be sufficient to add that, in general, *metallic alloys melt at a lower heat than is required to fuse the most refractory or infusible component, and sometimes lower than the most fusible ingredient.*

The color of an alloy cannot, in general, be inferred from that of its component metals; thus it would be conjectured that copper would be rendered very much paler by adding to it zinc in considerable quantities, but the fallacy of such an inference is at once shown by an examination of some of the rich-looking gold-colored varieties of brass, as Prince's metal, pinchbeck, and similor, composed each of nearly equal parts of copper and zinc; and Mannheim gold, compounded of three parts copper and one of zinc.

The affinity of an alloy for oxygen is greater than that of the separate metals, a phenomenon that is ascribed by Ure to the increase of affinity for oxygen which results from the tendency of one of the oxids to combine with the other; by others it is attributed to galvanic action. According to Faraday, 100 parts of steel alloyed with one of platinum is dissolved with effervescence in dilute sulphuric acid too weak to act with perceptible energy on common steel. It is offered in explanation of this fact that the steel is rendered positive by the presence of platinum. A similar illustration is afforded by the action of dilute acid on commercial zinc, which is usually an alloy of zinc with other metals.

The action of air is, in general, less on alloys than on the separate metals composing them. To this, however, there are exceptions, as the alloy of three parts of lead and one of tin, which, when heated to redness, burns briskly into a red oxid.

Some points of practical interest suggest themselves in connection with the behavior and proper management of alloys in the process of compounding.

As metallic alloys can only be formed by fusion, and as the affinity of the metals composing them for oxygen is greatly increased by heat, especially those denominated base, it is important

that this tendency, which is incompatible with the proportional accurateness of the compound, should be, as far as practicable, guarded against. Hence, various substances having a greater affinity for oxygen than the metals to be united, as oil or grease, rosin, powdered charcoal, etc., are generally added, coating the surface of the liquid metals, and which, by affording a protective covering, preserve, with little change, the proportions of the alloy.

The Difficulty of Securing a Homogeneous Alloy, Owing to the Difference in the Specific Gravities of the Metals Composing It.—Some difficulty is occasionally experienced in obtaining a perfectly uniform alloy, on account of the different specific gravities of the metals composing it—each metal assuming the level due to its density. This partial separation is common to gold and silver, provided they have not been adequately stirred before pouring. This result is not so likely to occur when the metals employed are in small quantities and are suddenly cooled, but when used in considerable masses and allowed to cool slowly, it is much favored by permitting the metals to fix themselves in the order of their separate densities. Hence, whenever a notable difference in the specific gravity of the metals exists, the fused mass should be briskly stirred immediately before the instant of pouring it, and should be made to solidify quickly. If uniformity be not obtained in this manner, it will be necessary to remelt, and repeat the process until the alloy is rendered sufficiently homogeneous.

The Metals that Should be Melted First.—In alloying three or more metals differing greatly in fusibility, or that have but little affinity for each other, it is better to first unite those which most readily combine, and afterward, these with the remaining metal or metals. If, for example, it is desired to unite a small quantity of lead with brass or bronze, some difficulty would be experienced in forming the alloy by direct incorporation of the metals, but union could be readily effected by first melting the lead with zinc or tin, and then adding the melted copper.

CHAPTER XII.

TREATMENT OF THE MOUTH PREPARATORY TO THE INSERTION OF ARTIFICIAL DENTURES.

It rarely occurs that all the structures of the mouth are in such condition as will render it proper to insert an artificial appliance without some preparatory treatment. This important requirement cannot, in any material respect, be disregarded by the practitioner without endangering the utility and permanence of the substitute, and inflicting upon the patient a train of consequences alike distressing and pernicious. Every experienced dentist is familiar with the fact that an artificial substitute, resting upon diseased roots of teeth and impinging continually upon gums already irritated and inflamed, soon becomes a source not only of annoyance and discomfort to the patient, but is rendered, in a great degree, inefficient in the performance of some of its more important offices. There is, besides, a perpetual and cumulative aggravation of the morbid conditions, and sooner or later irretrievable destruction of the remaining natural organs will be induced. These consequences cannot be wholly averted by the most skilful manipulation, but they may be greatly magnified by a defective execution of the work, or by a faulty adaptation of the appliance to the parts in the mouth.

Patients not infrequently attempt, by every artifice or pretext that caprice or timidity may suggest, to persuade the operator to violate his own clear convictions of duty, but, unless under circumstances of peculiar exigency, he should be careful to guard himself against the imputation of incompetency or bad faith by being peremptory and unyielding in his demands upon the patient to submit to the necessities and just requirements of the case, and no ordinary circumstance should influence him in opposition to his better informed judgment.

The conditions usually met with, to which it will be necessary to direct attention in the treatment of the mouth, are: (1) The presence of useless and diseased remains of teeth. (2) Accumula-

tions of tartar. (3) Diseased states of the gums and mucous membrane. (4) Caries.

Useless and Diseased Remains of Teeth.—It may be stated, as an absolute rule of practice, that all teeth, or remains of teeth, affected by incurable forms of disease, should be removed before inserting either partial or entire dentures. This recommendation must, however, be construed in the light of the curative resources of dental surgery and therapeutics. Many diseased conditions associated with the teeth that have heretofore been generally regarded as incurable, have, in the use of more radical and efficient remedial measures, proven amenable to such treatment as assures their retention for many years in a condition fitting them for important uses. A new impulse has of late been given to such conservative treatment of these organs with the view, chiefly, of utilizing them more generally for purposes of support in setting artificial crowns, and in the method of replacement known as "bridge-work."

The marked success which of late years has attended the treatment of diseased roots, and the increasing importance attached to them for the purposes mentioned, as well also as the essential office they perform in preserving the structural integrity of the associated alveoli, and in maintaining the normal circulation and nutrition of the parts, would seem to justify the conclusion that their extraction is plainly contraindicated, save in rare and exceptional cases of intractable disease, in which case there is no question concerning the propriety or necessity of their removal. Their presence in connection with the substitute must, sooner or later, become not only a source of annoyance and distress to the patient, but will, in all probability, lead ultimately to consequences of a still graver nature. Inflammation and suppuration will be likely to be induced, or, if already present, will be aggravated by the mobility and unaccustomed pressure of the substitute in the process of mastication, thus contaminating and vitiating the oral secretions, which act, by reason thereof, with increasing energy upon oxidizable materials present in the mouth, as well as upon the remaining natural teeth, while the contiguous parts, through their immediate connection or sympathetic relations with the structures of the mouth, respond to the local disturbances, and the case, in time, becomes complicated with those

various distressing maladies about the head and face so commonly associated with diseased conditions of the oral cavity. At last, the patient, no longer able to endure the offensiveness and distress arising from the presence of the substitute in the mouth, or to properly masticate his food, is compelled to have the offending organs removed. The absorption of the gums and processes which follows this operation, and the corresponding changes which occur therefrom in the form of the alveolar ridge, make it imperative either to reconstruct the piece or to supply the patient with an entirely new substitute; whereas, if due regard had been given to the proper preparation of the mouth in the first instance, the patient might be spared such inflictions, and the operator the discredit which almost invariably attaches to the neglect of the measures recommended.

Removal of Salivary Calculus or Tartar.—The deposits of tartar which so frequently collect at the necks of the teeth and under the free margins of the gum are a prolific source of evil, inducing ultimate destruction of the investing membranes and contiguous alveoli, and as this deposit is continuous and progressive, following closely the wasting or destruction of the implicated tissue, teeth originally firm become in time not only unfitted for the proper performance of the functions required of them, but a source of diseased action in surrounding structures. Hence it becomes absolutely necessary, as it relates to the general health of the mouth, to thoroughly remove, with suitable instruments, all traces of this concretion from the teeth. In some complications characterized by suppurating processes and necrosed alveoli, as in so-called "Rigg's disease," or pyorrhea alveolaris, the treatment must be more thorough and radical.

Diseased Conditions of the Mucous Membrane and Gums.—It will seldom be necessary to institute treatment for the reduction of inflammation and suppuration of the soft tissues of the mouth after removal of diseased roots and tartar, inasmuch as these conditions, being generally provoked by and associated with the latter, will spontaneously subside with the removal of the exciting causes. If, however, this does not occur within a reasonable time, relief may generally be obtained with the use, as a mouth-wash, of any of the remedies ordinarily employed, as dilute tincture of arnica, myrrh, or calendula, phenol sodique, etc.

As a means of allaying soreness or tenderness of the gums after extraction, the writer has had gratifying success in the use of Electrozone, or Pond's extract of hamamelis. If there are morbid conditions of the soft tissues or osseous structures of the mouth, not immediately arising from the presence of diseased roots and tartar, they should be treated in accordance with the particular pathological conditions present.

Caries or Decay of the Remaining Teeth.—In order that all the teeth which it is deemed advisable to retain in the mouth may be permanently preserved, it will be necessary to fill, or otherwise treat, such as may be affected by caries. This operation will be attended with more satisfactory results, and be accompanied with less pain to the patient and diminished risk of failure, when performed after the removal of the roots of teeth and tartar, and the restoration of diseased conditions of the mouth to health, as, in this case, there will be less irritability of the general system and reduced sensitiveness of the teeth operated on.

Surgical Treatment of the Mouth After the Extraction of Teeth.—In the operation of extracting preparatory to the insertion of artificial dentures, especially in cases accompanied by unavoidable fracture of the processes, it sometimes happens that loose and pendulous portions of gum remain, giving temporary annoyance to the patient. Any considerable excess of such tissue may be, in part at least, clipped off, while sharp and protruding portions of processes at other points should be removed, for, if allowed to remain, the gum closing over them will, in a short time, become irritated and inflamed, and exceedingly painful to the slightest pressure. If, in the course of a few weeks, prominences still remain, over which the mucous membrane is stretched and irritated or inflamed, as is more frequently the case around the sockets of the cuspid teeth, the membrane should be divided over such points with a lancet, and the sharp points of bone underneath broken down with suitable cutting instruments. This condition, however, can usually be obviated, in a measure, by firmly pressing the process together immediately after extraction.

Time Necessary to Elapse After the Extraction of Teeth Before Inserting Artificial Dentures.—The time that should elapse after extracting the natural teeth, before replacing them with artificial substitutes, will depend upon various circum-

stances. If the appliance is only intended to meet the wants of the individual until all the changes effected by absorption of the gums and processes are fully completed, it may be inserted in from one to three weeks, depending somewhat upon the number of teeth extracted, the extent of the injuries unavoidably inflicted upon the parts, and the virulence of the diseased action present in the structures of the mouh at the time of the operation. If there are no unusual complications, and the space or spaces to be supplied are such as are made by the loss of only one or two teeth at intervals, the parts quickly assume their normal condition, and the piece to be temporarily worn may be applied within a few days. If, however, a greater number, or all of the teeth have been removed, more or less inflammation and tenderness will be present for from ten days to two or three weeks, rendering the wearing of an artificial piece uncomfortable to the patient, and in some degree mischievous, by aggravating the morbid conditions already existing. Another objection to the too early introduction of artificial substitutes into the mouth arises from the fact that the changes which occur in the ridge are much more rapid within the first few weeks after the extraction of the teeth than at any subsequent period, so that the plate, if inserted immediately or within a few days after such an operation, will soon lose its bearing upon the ridge and become inefficient for masticating purposes, or may even fail to be retained in the mouth without much annoyance to the patient. From two to eight or more weeks should, therefore, elapse before inserting the substitute. In the meantime, the patient should be seen frequently, and such medical or surgical treatment adopted from time to time as the case may demand.

The time occupied in the *completion* of those changes which occur in the alveolar border after the extraction of all or any considerable number of the teeth cannot be definitely stated, but will range from five to twelve months or more, according to the amount of superfluous structures to be removed, the density of the osseous tissues, and the functional activity of the absorbents. In all cases, ample time should be permitted to elapse in order that no appreciable change in the form of the parts may take place after the appliance has been permanently adjusted. It should be remembered, however, that there is no period of time when the

changes in the maxillary bones which follow the extraction of the natural teeth may be said to be absolutely completed. It is well known that, in exceptional cases, renewed absorption may occur long after the time when it is supposed to be completed, extending in some cases quite beyond the ordinary limits. This is ascribed by many to misfitting plates, or to some particular quality of the material used as a base, notably vulcanized rubber. While there may be some plausibility in this view, it can hardly be accepted as final or conclusive. That the unusual destruction or wasting away of involved tissue is induced by some abnormal action of the absorbent or nutritive processes is without question, but whether this is induced by local or systemic causes remains in doubt.

CHAPTER XIII.

MATERIALS, APPLIANCES, AND METHODS EMPLOYED IN OBTAINING IMPRESSIONS OF THE MOUTH.

In the process of constructing a dental substitute, it is of the first importance that as accurate an impression as possible should be obtained of all those parts of the mouth with which the appliance is in any way connected. *If this important preliminary step is in any essential respect imperfectly performed, the ultimate utility of the artificial fixture will either be greatly impaired or wholly destroyed,* notwithstanding all the subsequent manipulations may be most carefully and skilfully performed. The operator, therefore, should not only avail himself of every appliance and facility that will enable him to attain the most perfect results, but should have an exact and intelligent acquaintance with the nature, properties, and adaptability of the impression materials used.

The substances usually employed for this purpose are: beeswax, modeling composition, and plaster-of-Paris.

Some diversity of opinion exists as to the relative value of these several impression materials, and the choice of any one of the class is generally determined by individual notions of the indications to be fulfilled in any given case, and the supposed special adaptability of the material to the fulfilment of such indications.

In the case of entire dentures, where there is a near approach to uniformity of hardness or softness, and consequent uniformity of resistance, in the tissues of the mouth, plaster, of the proper consistency, unquestionably takes precedence of all other materials for the purpose, and the almost universal preference given to it in such cases is a virtual confession of its superior fitness. Its capability, beyond that of all the other substances mentioned, of securing the most perfect impression of the several parts in their undisturbed relation to each other is unquestioned, and it may be affirmed with positiveness that, except, possibly, in the case of plastic bases, where there is no compensation for the slight expansion of the plaster, if all the surfaces on which the substitute

rests were equally pliant or equally resistant to forces applied to them, no other material would be required. But, strictly speaking, this condition of uniformity never prevails, and in many cases there is a marked departure from it. The most common and troublesome complication of this kind occurs where there is a more or less pliable or yielding condition of the alveolar ridge associated with a comparatively hard and resistant surface along the median line of the floor of the palate, being more pronounced near the soft palate. In such cases, this inequality of softness and hardness, if considerable, prevents a properly balanced contact and pressure of a substitute constructed from an impression of the parts in a state of repose. Thus, for example, in the case of a perfectly fitting denture secured in the manner just stated, if the ridge along the mesial line of the palatal vault is more than usually hard and prominent, and the lateral portion of the arch and alveolar ridge relatively soft and yielding, the substitute, meeting with a fixed point of resistance at the floor of the palate, will prevent the lateral walls and ridge from being sufficiently compressed on the application of retaining forces, whether atmospheric, adhesive, or capillary, or all combined. Hence, when forcible pressure is made on one side over the ridge, as in mastication, the substitute, impinging or riding upon the central resistant surface of the arch, as upon a pivotal point, will be detached and thrown off from the opposite side. If the same yielding condition of the anterior portion of the ridge prevails, the appliance, when forces are applied to the front teeth, will be dislodged posteriorly.

The proposed remedy for the instability of the substitute, resulting from the conditions mentioned, consists in so constructing the dental appliance that, when applied to the mouth and subjected to the action of the retaining forces, a degree of resistance in those parts where the soft tissues are in excess will, through compression of the tissues, be secured, equal, or nearly so, to that presented by the central portion of the arch; in other words, by establishing an equilibrium of pressure or resistance in all the parts on which the plate rests.

It is believed by some teachers, that certain forms of impression material, through the pressure they exert, are capable of contributing materially to this result. This is predicated on the

assumption that the pressure they exert is sufficient to compress or displace the tissues in question. The writer, however, thinks it well to inquire if the compressing power of these substances, in the cases under consideration, has not been overrated. If by the term compression, as used in this connection, is meant condensation or diminished bulk of tissue, certainly no such result could be obtained by any force capable of being applied within the mouth, however hard and resistant the material used. Any change in the normal configuration of the arch and ridges possible in the use of such substances must, therefore, result, *not in condensation, but in displacement of tissue.* It can be readily understood how this displacement may occur along the summit line of the ridge in cases characterized by considerable excess of gum material lying in loose and gristly folds, chiefly in front of the bicuspids, and associated generally with the long use of partial dentures. In applying pressure in such cases, the effect would be to force these mobile structures out of their customary relations to the ridge and arch. How far such a procedure is in accordance with the principles of correct practice must be submitted to individual judgment. That any change in the mere relative position of such loose structures to the ridge would contribute in any appreciable manner to the stability of the substitute is not very apparent.

Within the limits of the maxillary arch or palatal vault, the fossæ or depressions lying on either side of the central line are filled more or less completely with a mass of comparatively soft but elastic areolar, cellular, or connective tissue, which, in its unchanged condition, is thought practically to interfere, in many cases, with a properly balanced contact or bearing of the substitute. A partial remedy, at least, it is claimed by many, may be found in the use of some impression material of sufficient firmness to compress or displace such tissues sufficiently to afford points of resistance to the substitute equal, or nearly so, to that offered by the median line of the arch. The displacement here, if any, would be in the direction of the least resistance, or toward the velum or soft palate, all portions of the arch anterior to the latter, except in the case of an air-chamber, offering effectual resistance to displacement in any other direction. When the nature and relations of these associated soft structures of the mouth are

considered, it is highly improbable, and we think impossible, that any appreciable change of contour within the arch could take place on the application of any force applied in the use of either wax or modeling composition. If these conclusions should be justified by experimental tests, as we believe they would be, it would be practically unimportant, except where the tissues of the ridge are characterized by unusual mobility, what material was used, provided a perfect impression could be obtained with it. The paramount merits of plaster, as a substance capable beyond question of fulfilling perfectly this requirement, would therefore recommend it, in preference to any other material; and we might add, too, that *the more difficulties there are presented* in securing an accurate impression, *the more reason there is for using plaster-of-Paris* as the impression material.

One possible result of the use of any of the impression materials named, exclusive of plaster, both in full and partial cases, must always render their employment of doubtful expediency whenever plaster can be successfully manipulated for the same purpose, namely, their great liability to distortion on the application of forces necessary to detach them from the mouth, and the impossibility of detecting any change of form until the error, too late for correction, is revealed in a faulty adaptation of the finished piece to the mouth. It must not, however, be understood from this that it is impossible to secure a practically accurate impression of the parts in the use of these materials. The purpose is, rather, to impress the importance and absolute necessity of extraordinary care in their manipulation in order to secure satisfactory results. The relative liability of the several substances named to such disturbance of form, and the precautions necessary to avoid such an unfortunate and generally fatal accident, will be more particularly noticed when we come to treat of them individually as impression materials. This will be done in the order before named.

Beeswax.—There are two varieties of this substance in common use, the *yellow* and *white* wax. The more desirable properties of the yellow wax are often impaired by the admixture with it of tallow, with which it is, for mercenary purposes, frequently contaminated. The presence of tallow may be detected by its characteristic odor, and by the whitish or pale yellow color it imparts to the wax, which in its pure state is of a deep, bright straw color.

Wax used for impressions should always be kept in convenient form for immediate use, and may be prepared either by warming it until sufficiently soft and then rolling or pressing it into thin sheets; or, having melted it in a properly formed vessel, immerse in it a strip of thin board, previously moistened, and withdraw quickly; this is repeated as the successive layers cool, until a coating of sufficient thickness is obtained. The latter is a convenient method of obtaining sheets of wax of a uniform thickness, a form frequently required for various purposes in the dental laboratory.

The following directions in the use of wax will apply also to its combinations with paraffin and gutta-percha, and also to modeling compositions.

Manner of Obtaining an Impression of the Mouth in Wax for Partial Upper Dentures.—Until within the past few years, wax has been used almost exclusively for the purpose of obtaining an impression of the mouth in those cases where any number of the natural teeth remain in either or both jaws; for this purpose it is ordinarily more convenient and manageable than plaster, and, if carefully manipulated, will secure in many cases a sufficiently accurate impression of the parts.

Before preparing the wax, a suitable impression-cup or tray should be selected, conforming as nearly as possible in size and shape to the general form of the arch and ridge. The proper size should always be determined by trial of the empty cup in the mouth before taking the impression.

Impression-cups are made from a variety of substances, as sheet-tin, porcelain, vulcanized rubber, and Britannia metal, and sometimes, in order to meet the requirements of special or exceptional cases, either brass, copper, block-tin, or gutta-percha may be used.

Cups constructed of sheet-tin, which any tinner can readily make to order, were formerly very generally used for partial cases, and if proper care is taken not to inflict injury to the lips and soft parts with the thin, sharp edges, when introducing and pressing the cup to its place in the mouth, they may be used with satisfaction.

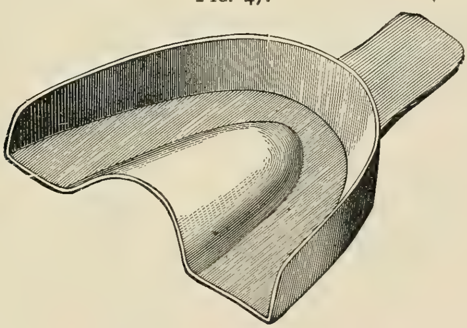
Porcelain cups are adapted to the use of the several impression materials named, except plaster, the latter being quite liable to part from their glazed surfaces on the application of the necessary force to detach the impression, leaving the plaster in the mouth. Aside from their purity and attractive appearance, they possess

no advantages that would make them preferable to Britannia cups, while they are objectionable because of their liability to injury, and entire incapability of being changed in form to meet special requirements. When used in connection with wax, they should be slightly heated before the former is introduced.

Hard-rubber trays, of any desired form, may be readily made from plaster models by any one accustomed to rubber work, and are chiefly adapted to the use of plaster, as they are not readily cleansed if other than plastic substances are employed. Their form may be materially changed by immersing them for a few moments in boiling water.

Britannia metal, however, meets most fully all the requirements of an impression-cup, and is well adapted to the use of any of the impression materials commonly employed. The great variety in form and size found at dental depots, will amply meet all the requirements of ordinary cases. For unusual or abnormal conditions requiring exceptional forms of trays, the operator can construct for himself, from these, such appliances as will best serve his purpose in the individual case.

Fig. 47.

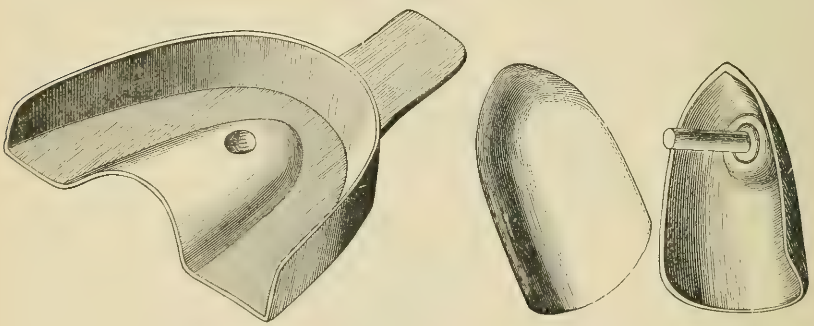


The Form of Cup to Use.—Whatever cup is selected in securing an impression in wax for a partial upper case, it should be large enough to embrace the alveolar ridge, leaving a space of nearly ¼ of an inch between the rim and the external wall of the alveolar ridge. In partial upper cases requiring an impression, it may be, of only a limited portion of the arch, as where clasps are used, or of the entire hard palate, the form of cup illustrated in Fig. 47 should be employed.

A cup designed for similar cases by Dr. Wardle, exhibited in Fig. 48, is particularly adapted to high arches, being provided with a movable palate plate, by which the central portion of the impression material is effectually forced into the highest portions of the palatal arch, and laterally against the sides and necks of the remaining teeth. The same result can be accomplished, however, by using the ordinary impression-cup, and building up the rear and center of the palatine portion with softened beeswax, before introducing the plaster.

Having selected a cup of the proper form and size, the wax should be warmed over a spirit-flame until it acquires about the consistency of freshly-made putty. Wax is sometimes softened by immersing it in hot water, but the dry heat is preferable, as the former seems to impair, to some extent, its toughness and continuity.

FIG. 48.



The Position of the Operator.—In taking the impression the operator should place himself behind and to the right of the patient, and should be sufficiently raised above the latter to enable him to manipulate with the greatest ease and certainty, and at the same time to command as full and unobstructed a view of the interior of the mouth as possible.

Manner of Introducing the Cup, etc.—The cup, with the wax arranged should then be introduced into the mouth without unnecessary delay. To do this properly, and without subjecting the patient to annoyance, will occasionally require some care and expertness, on account of the disproportionate size of the cup and orifice of the mouth. An ample and expanded jaw, for example, is frequently associated with a small mouth, and if in addition to this the sphincter muscle of the mouth happens to be rigid and

unyielding, the introduction of a cup of sufficient size may be attended with some difficulty and embarrassment. This impediment, however, may be readily overcome in most cases by presenting the cup obliquely to the mouth, one side resting against, and pressing outward, the corner of the mouth, while—as the opposite corner is extended with the first and second fingers of the left hand—the cup is passed in with a rotary movement.

When the cup is within the mouth it should be carefully adjusted over the ridge before pressing it up, so that no portion of the rim may cut into the soft tissues of the mouth, an accident liable to happen without care, and which will make it necessary, in most cases, to withdraw the cup before the impression is complete. The proper position of the cup in the mouth secured, it should be held firmly with the thumb resting on the handle above, and two or more of the fingers on the under surface, when it is slowly but steadily and forcibly pressed against the parts above until the ridge is completely imbedded, and the wax carried closely against the roof of the mouth. The cup should then be held stationary with two fingers from each hand; applying equal pressure upon both sides, while with the thumbs the wax around the margins of the cup should be pressed closely into all the depressions occurring on the outside of the ridge between the remaining teeth, or wherever irregularities may present themselves on the external border of the jaw.

After the wax has remained in the mouth long enough to become in some degree hardened, it should be carefully detached by gentle traction upon the cup, and removed from the mouth in the same manner in which it was introduced, care being taken not to displace the wax or otherwise mar the impression. The force with which the wax impression will adhere to the mucous surfaces on the complete exclusion of air is oftentimes very considerable, and will require a corresponding tractive force to dislodge it. In applying this force, it should be borne in mind that, in the very plastic condition in which the wax is applied to the mouth, *it is not only very soft and yielding, but, being wholly inelastic, is incapable of recovering its form when temporarily disturbed,* and that, consequently, any distortion of the impression occurring from the force applied in removing it from the mouth will be permanent and possibly fatal. It should, therefore, as has already been

stated, be allowed to remain in the mouth long enough to become somewhat hardened, say from three to five minutes, and this process may be facilitated by holding against the cup a napkin saturated with cold water. The proper degree of hardness will, however, depend upon the circumstances of the case. If the remaining teeth present to each other parallel walls, or nearly so, permitting an easy escape of the wax from the interdental spaces, the greatest practicable degree of hardness that can be obtained is desirable. If, on the other hand, these spaces are V-shaped or dovetailed, as is very generally the case where the teeth to be replaced have been long absent, the impression should be removed while the wax is somewhat plastic, permitting a ready separation by such displacement of wax immediately around the adjoining teeth as must always occur in these cases in the use of wax. In proportion as the wax is rendered hard and unyielding will be the resistance to its escape from these spaces, and the danger of change of form in parts of the impression more or less remote from them augmented. It is, therefore, unadvisable in such cases to produce hardness artificially by the application of ice or cold water. Under similar conditions, the same precautions should be taken against overhardening in the use of modeling composition.

Imperfections occurring from displacement or dragging of wax on removal from the mouth, if inconsiderable, may be remedied with tolerable accuracy by subsequent carving of the plaster model, and this may be aided by a comparison of the plaster representation of the teeth with those in the mouth. If, however, the interdental undercuts, and those associated with bell-crowned teeth at other points, are more pronounced, it is better to use either the modeling composition or plaster.

Inasmuch as it is necessary, in constructing partial sets of teeth where swaged base-plates are used, to be provided with two or more plaster models, and as the latter cannot well be obtained in perfect condition from a single impression, it is better that at least two of the latter should be secured in the first instance.

Manner of Obtaining an Impression of the Lower Jaw in Wax, for Partial Dentures.—If the case is one where teeth at intervals are to be supplied, the form of cup illustrated in Fig. 49 may be employed. If, however, as is more generally the case, the front teeth remain, and those posterior to the cuspids or bicuspids are

to be replaced, the form of cup exhibited in Fig. 50 should be used, a portion being cut out from the front part of it, forming a vacuity which receives and permits an unobstructive passage of the front teeth. As the latter are often very long, it is difficult, with the ordinary form of cup, to press the wax down fairly upon the ridge behind without bringing their cutting edges prematurely in contact with the floor of the cup in front. Instead of the opening represented in the cup, however, it will be sufficient in most cases to have it formed with a depression in front of adequate depth to receive the points of the anterior teeth.

Position of Operator.—In taking an impression of the lower jaw, after having prepared and arranged the wax by softening and filling the groove of the cup flush with the margins, the operator may first take a position to the right and back of the patient and introduce the cup into the mouth in the manner heretofore de-

FIG. 49.

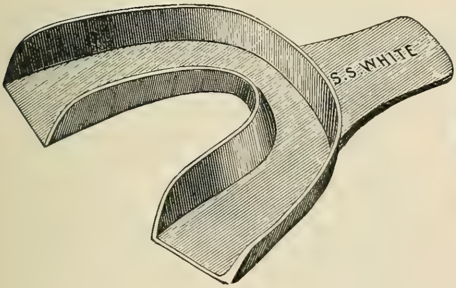
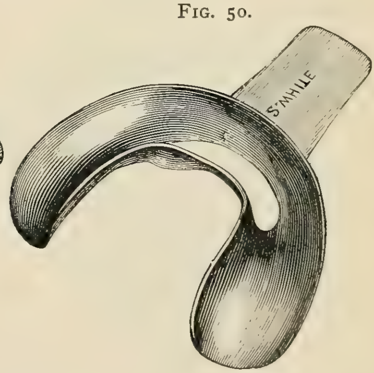


FIG. 50.

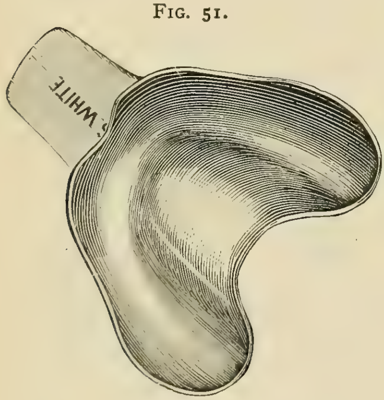


scribed, when he may pass a little to the front of the patient, and, having adjusted the cup properly over the ridge, he should then take his place again, at the side or back of the patient, placing his fingers of each hand under each side of the patient's jaw, and the thumbs upon the top of the cup; then make steady pressure until the ridge is wholly imbedded. Before final adjustment of the wax to the ridge, however, care should be taken not to enclose any loose folds of membrane along the line of junction between the ridge and cheeks, or of loose tissue lying on the inside near the base of the tongue. To avoid the former, immediately before final pressure is made, the cheek should be distended and drawn outward with the finger, first on one side and then on the other,

holding the cup, in the meanwhile, steadily in place. The loose and movable tissues on the inside will be drawn away from the ridge somewhat if the patient is directed to raise the tongue well toward the roof of the mouth. Some little additional pressure may then be made upon the cup, after which the wax should be pressed in around the margins of the cup, both externally and within, when the impression is carefully removed from the mouth, observing the precautions stated when treating of wax and other allied substances.

Manner of Obtaining an Impression of the Mouth in Wax, for Entire Upper Dentures.—The form of cup employed in taking an impression of the upper jaw, in the absence of all the natural teeth, is seen in Fig. 51. A number of these corresponding as nearly as possible in form and size to the various modifications in the configuration and dimensions of the maxillary arch, should be kept conveniently at hand. If the teeth have been recently extracted, the wax should be prepared somewhat softer than usual, to prevent displacement of the gums, which, in their unabsorbed condition, possess more or less mobility. The cup should be filled flush with the edges, and built up in the center if the depth of the palatal vault requires it, and the wax properly trimmed; it is then introduced into the mouth and adjusted to the ridge, as already described, and pressed to the jaw with sufficient force to fully encase all the parts to which the substitute is ultimately to be applied. The wax, as the cup is pressed up, has a tendency to roll out at its edges, and thus depart from the upper and outer portions of the ridge; hence care must be taken to press the wax in around the marginal portions of the cup, as has previously been directed, filling up any depressions or fossæ that may occur on the external border of the jaw. It is particularly necessary to observe this precaution whenever the ridge overhangs, as is prominently the case for the first few months after the extraction of the teeth.

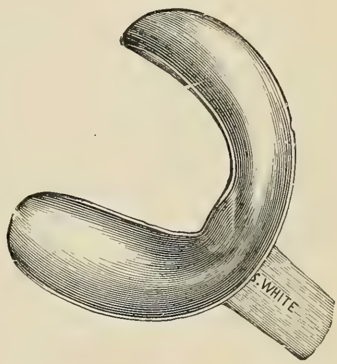
Fig. 51.



If the impression is an accurate one, some difficulty is occasionally experienced in detaching it from the mouth, on account of the thorough exclusion of air from between it and the mouth the wax being held firmly in place by adhesive force; in which event it is only necessary to admit the air between the two; and this may generally be readily effected by placing the finger against the jaw on one side and above the wax, pressing firmly toward the center of the arch and upward, forcing the muscles and mucous membrane somewhat from the edge of the cup, and at the same time depressing the latter on the same side. A small portion of air being admitted, it will soon diffuse itself between the adhering surfaces and allow the wax to be readily detached.

To harden the wax, so as to prevent it from dragging at the points where the ridge overhangs, or to prevent any change in its shape on the application of sufficient force to detach it from the mouth, inject under the lip and upon the cup a stream of cold water, sufficient to chill the wax.

Fig. 52.



The writer would repeat, in this connection, his conviction that it is impracticable, in most cases, to obtain a faultless impression of the mouth in wax. There are points, not readily accessible to the fingers, where the wax departs from the external and posterior borders of the jaw, and is not, therefore, susceptible of easy correction; besides, when reached and the remedy applied, there is no certain assurance that in pressing the wax in at one point we are not displacing it at another. The same uncertainty, to a less degree, in regard to results also attaches to the use of the modeling composition. For this reason, we almost invariably use plaster, and we have sufficient reason to believe that the results are more uniformly successful.

Manner of Obtaining an Impression of the Lower Jaw in Wax, for Entire Dentures.—The method pursued in securing an impression of the lower jaw in wax for an entire denture differs in no essential respect from that described when taking an impression for lower partial pieces, the form of cup being represented in Fig. 52. When the parts are imbedded in the wax, the latter

should be pressed in around the inner border of the holder, but more especially near the posterior part of the ridge on each side where the latter overhang and approximate each other, forming corresponding excavations underneath. After adjusting the wax to the ridge along the border of the cup, the latter should again be pressed directly down upon the jaw before removing it, to correct any partial deformity that may have occurred during the previous manipulations.

Modeling composition, of late years, has largely superseded the use of wax for impressions. It is compounded of gum dammar, stearin, French chalk, carmin, for coloring, and some perfume. The consistence of the mass depends upon the relative quantity of stearin and chalk introduced, the grades as manufactured being designated as soft, medium, and hard.

This material takes a sharper impression of the parts than wax, and its elastic property makes it more suitable where there are overhanging ridges, irregularly arranged and bell-crowned teeth, and dovetailed interdental spaces. It is prepared for use by softening it either with dry heat, or by immersing it in hot water. When sufficiently plastic, it is introduced into a cup slightly heated to render the material somewhat adhesive, and then placed in the mouth as has been directed for wax impressions.

Before removing it from the mouth, it should be cooled somewhat in order to preserve its form unchanged. Excessive hardness, however, should be avoided where portions are pressed into unusual undercut spaces, as the force necessary to detach it in such cases may produce deformity of the body of the impression, more or less remote from the teeth and spaces mentioned. When removed it should be immediately dipped in cold water. The general manipulation of the compound in the mouth, both in full and partial cases, is the same as that described when wax is used, and the same care should be observed when removing the impression from the mouth.

Moldine.—This plastic compound, originated by Dr. George W. Melotte, and used by him chiefly in connection with crown- and bridge-work, is composed of potter's clay mixed with glycerin to the consistency of stiff putty. With the observance of certain precautions in the use of this material, the operator is enabled very quickly to secure a metallic die and counter-die immediately from the impression.

The following, in substance, is Dr. Melotte's method of using it and of obtaining the die and counter-die. Make the tooth or teeth perfectly dry, and, filling the cup (Fig. 53) nearly full with moldine, coat it with soapstone powder, and take the impression in the usual manner. Carefully remove the cup; trim off any overhanging material, and place the rubber ring (Fig. 54) over the cup to about one-half the depth of the ring. Melt the fusible metal and pour it as cool as it will run from the iron ladle. As soon as the metal is hard, remove it with the ring, taking care not to impair the impression, which can be used again if the die is found imperfect or is injured in use. Place the die and ring in cold water, to remain until quite cooled. While the die is wet and held over a basin of water, pour into the ring fusible metal which has been stirred until it begins to granulate, and quickly immerse

FIG. 53.

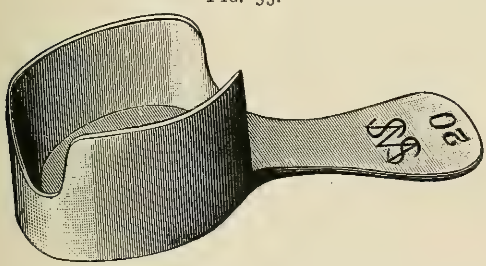
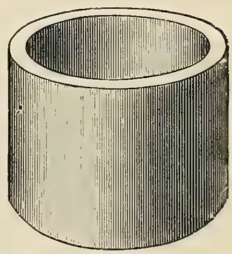


FIG. 54.



all in the water. The die and counter-die should separate readily by tapping them with a hammer, but if they stick, others can be quickly made from the same impression, by the same method, using more care.

Plaster-of-Paris.—Plaster-of-Paris, or, technically, calcium sulphate, has been long employed in taking impressions of the mouth for entire dentures, and of late years it has almost entirely superseded the use of all other materials, on account of its capability of receiving a practically faultless imprint of the parts on which the substitute rests. The same quality of exactness recommends it also in partial cases where conditions exist that render an accurate impression of the parts with other materials impossible.

Derivation.—Plaster is derived from gypsum by a process of calcination. The latter, or gypsum, is a common mineral, frequently crystallized, oftener amorphous, and oftentimes forming rock masses. Its transparent variety, called selenite, sometimes

occurs in large plates, which have been used for windows. It also frequently occurs in aggregated needle-like crystals, and is then called fibrous gypsum. In its amorphous condition, when compact and translucent, it is named alabaster. More commonly it is white, opaque, and soft, and is then called snowy gypsum. The most important deposits known are those of the Paris basin at Montmartre, from which it has taken the common name of plaster-of-Paris.

Manner of Preparing.—In the preparation of plaster, as used in the arts, the gypsum rock is ground between burstones until it is reduced to a fine powder, when it is calcined by being heated in kettles or stills, the combining water being thus driven off. If, in this condition, it is again mixed with water, the latter recombines with it, the mass becoming first plastic, and then solid. Hence, it is admirably adapted to a great variety of modeling processes. In its ordinary calcined form, plaster absorbs moisture from the atmosphere, *and should, therefore, be carefully protected from dampness.* Should the latter occur, however, the uncombined moisture may be driven off by exposing the plaster to a moderate heat in a shallow pan or other suitable vessel.

In the process of hardening, after having been made plastic by the addition of water, more or less expansion of the mass, both during and for a time after solidification takes place, varying with the kind of plaster used and the various methods employed in preparing it for molding purposes.

To hasten the setting of plaster use warm water for mixing, or add about ten grains of common salt (sodium chlorid) to the water before introducing the plaster, when about to take an impression. The salt also makes the plaster more brittle, which is desirable in impressions. It is better to add the salt before the plaster, as it gives it a better opportunity to become uniformly diffused. Other agents, such as chlorate of potash, potassium sulphate, and alum, have been and are used to hasten the setting of plaster; but salt is the least objectionable and answers every purpose.

Manner of Obtaining an Impression of the Mouth in Plaster, for Partial Upper and Lower Dentures.—In partial cases, whether above or below, there are, almost universally, conditions associated with the presence of the remaining natural teeth,

which, until more recently, have been thought to contraindicate the use of plaster as an impression material, but experience has demonstrated that, with the adoption of certain available means and careful and skilful manipulation, there are few if any cases in which this material may not be successfully employed. Its superior capabilities of receiving a faultless imprint of the mucous surfaces recommend it for this purpose in all suitable cases.

The conditions mentioned above relate to those cases where the cervical portions of the crowns are relatively small; or where the teeth are irregularly arranged in the circle, having either an anterior, posterior, or lateral obliquity; or where there are marked depressions or fossæ on the external border of the alveolar ridge; and especially where there are well-defined dovetailed or wedge-shaped interdental spaces. These conditions prevail in different degrees in individual cases, and the instances are exceedingly rare where some or all of them are not present. As plaster prepared for impressions, in the act of setting or hardening, becomes rigid and unyielding, and therefore practically incapable of any change of form by distortion or dragging of any portion of it on traction, the difficulty, not to say impossibility, of detaching it by the ordinary means, where these conditions prevail, will be apparent. In cases of very slight deviation from the normal position of the teeth, sufficient force, judiciously applied, will disengage the impression, provided the plaster is not allowed to set hard.

If the mal-arrangement of the teeth is considerable, or very pronounced, the separation of the plaster impression must be accomplished in some other way than by simple traction. Prof. Charles J. Essig recommends the following method of procedure:

"An impression-cup should first be selected of the proper size and shape—those with the flat floor (Fig. 47) are best for partial cases; the plaster should be mixed quite thin, adding chlorid of soda to facilitate setting. Plaster mixed in this manner does not become so hard and unyielding as that mixed merely to saturation. Now oil the cup so that it will readily separate from the impression when hard; fill the cup as soon as the plaster thickens sufficiently, then, with a small spatula, place a layer of the soft plaster in upon the palatine surface, otherwise, by enclosing the air in the deep portion of the arch, the accuracy of the impression

may be impaired. After this precaution, the cup is placed in the mouth, and gently pressed up until its floor comes in contact with the teeth. When the plaster is sufficiently hardened, remove the cup, which, from its having been oiled, is done without difficulty; with the thumb and index finger break off the outside walls; the portion covering the palatine surface is then removed by the use of a blunt steel spatula, curved at the end in the form of a hook. The pieces are then placed back into the cup, where they will be found to articulate with perfect accuracy.

"Should the first attempt be rendered futile, by the tendency to nausea or troublesome gagging on the part of the patient, camphor water, as recommended by Dr. Louis Jack, may be used as a gargle, which will, in nearly every case, prove an effectual remedy."

This device is effectual to the extent described by Prof. Essig, but it affords only a partial remedy for difficulties which present themselves in many of these cases. The most formidable obstacle to the removal of a plaster impression will be found generally in that portion of it embraced in wedge-shaped interdental spaces, and undercuts formed by truncated, cone-shaped crowns, and malpositions of the teeth; and when the outside walls of the impression alone are broken off, and remaining portions are imbedded in these undercuts, it will rarely be possible to remove the portion covering the palatal surface without further fracture and removal by sections.

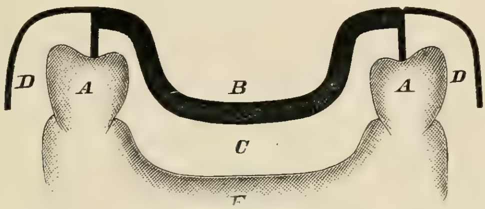
The writer is indebted to Prof. Wilbur F. Litch for the following description and illustration (Fig. 55) of a method of securing plaster impressions for partial cases:

"A wax impression-tray is made, and either scored or perforated, to afford anchorage for the plaster. This extends only midway of teeth or interspace. After the plaster has hardened, the outer edge is trimmed, notched, and oiled in the mouth, and sections D D of the diagram made by carrying plaster into position by means of a spatula, the outer section being made in two pieces, joined at about the median line. The three pieces are removed separately and joined by means of the notches made in the palatine section C, into which notches the plaster of sections D D will fit. After the three sections are cemented together, they may be imbedded in plaster, to more securely hold them together while the model is being poured."

Another method of securing plaster impressions in sections is the following, suggested by Dr. A. G. Bennett:

"A wax cut-off is placed in the floor of the impression-tray in such manner that it will touch the crowns of the molars and the cutting edges of the incisors about midway between their buccal

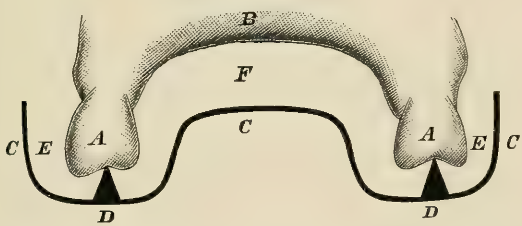
FIG. 55.



A A. Teeth or interspace. B. Wax impression-tray. C. Plaster impression of palatine vault and palatal half of teeth or interspace. D D. Buccal or labial half of teeth or interspace. E. Palatal vault.

or labial and palatine walls, as shown in Fig. 56, letters D D. After the wax cut-offs have been firmly attached to the tray by heat, the tray is oiled, filled with plaster, and placed in position in the mouth. After the plaster has hardened, the tray is withdrawn, the plaster remaining in the mouth, when the outer sec-

FIG. 56.



A A. Molar teeth. B. Palatine vault. C C C. Impression-tray. D D. Wax cut-offs. E E. Labial sections of plaster impressions. F. Palatal section of impression.

tions, E E, are readily broken off, and the plaster section, F, withdrawn. The several pieces are then replaced in their proper position in the tray."

Another method of procedure in the class of cases under consideration is that described by the late Dr. F. M. Dixon, of Philadelphia, which seems to provide more perfectly for the removal of the palatal portion of the impression in cases characterized by un-

usual inward inclination of the teeth. The process described relates to partial upper cases:

"First take an impression of the whole upper jaw in wax, and harden by applying ice-water. Divide this impression, with a slightly heated knife-blade, into the number of sections desired for the plaster impression. From the inner surfaces of these sections, a sufficient quantity of the wax is cut away to make room for the required amount of plaster. Hard-setting plaster is then poured into one of the palatal sections, and the latter placed in its proper position in the mouth, securing an impression of the palatal surfaces of the teeth of that side, and about one-third of the palate of the same side. When the plaster has hardened sufficiently, the section is removed and laid to one side while an impression of the opposite side is secured in the same manner.

"The patient may now be dismissed with an appointment for another sitting. In the interim, these sections are carefully trimmed in such a manner that the lower or lingual surface shall present a bevel from margins near the mesial line of the palate to the grinding surfaces of the teeth, that the next section may be readily removed after the hardening in the mouth. When the patient returns, the prepared lateral sections, oiled on their under surfaces, are placed in the mouth, and an impression of the central portion of the palate and palatal surfaces of the incisors is secured as before. The impressions of the buccal surfaces, when needed, are taken in like manner, with the other sections *in situ.*"

Manner of Obtaining an Impression of the Mouth in Plaster for Entire Upper Dentures.—The form of cup used in securing an impression of the upper jaw for entire sets of teeth differs in no essential respect from that recommended when wax is used for similar purposes (Fig. 51). If the external border of the alveolar ridge is very deep, or there is considerable space intervening between the heel of the cup and the floor of the palate, a rim of wax should be placed across the posterior border of the cup, to carry the plaster well up at this point, so as to secure an accurate impression, and more effectually to confine the plaster within the cup and prevent its escape into the back part of the mouth before it has fairly reached the palatal vault. If the latter is extremely deep, with a marked excavation in its central and anterior portion, or if it presents, somewhat, the form of a deep fissure, the

plaster may fail to be carried perfectly against the floor of the palate, or the air, becoming confined within the central portion of the arch, when the plaster is pressed up, may displace the latter and form corresponding chambers in the impression. If these imperfections are but slight, they may be subsequently remedied either by filling up the cavity or cavities in the impression, or by trimming away at these points from the model. The better plan, however, where these conditions of the vault prevail, is to take up a small portion of plaster on the end of a spatula and apply it to the deeper portions of the arch just before introducing the cup. In preparing plaster for use in these cases, it should be so treated as to insure quick setting when applied to the mouth. This is generally accomplished either by adding to a very thin mixture of plaster and water a small quantity of sodium chlorid or common salt and stirring until it begins to thicken. It then adapts itself readily to the parts, hardens quickly, and is not liable, with ordinary care, to incommode the patient by running back too far upon the soft palate or into the fauces. So quickly, indeed, does it condense, that unless expeditiously introduced into the mouth, it will begin to "set" before the parts are fairly imbedded. When preparing it for use, therefore, the plaster should be mixed at the chair with the cup conveniently at hand, while the patient should be in proper position, and in immediate readiness for the operation.

In view of the liability of the plaster to run back into the fauces when the cup is pressed to its place in the mouth, producing nausea and involuntary retching, and which is very liable to occur whenever the mixture is too thin or is improperly manipulated, it is recommended to instruct the patient to avoid swallowing while the plaster is in the mouth, and to breathe entirely through the nostrils, which act keeps the mouth and throat quiet, and hence less liable to irritation from the impression material, and the accumulation of saliva in the mouth.

Position of Patient, etc.—The patient being seated as nearly upright in the chair as possible, with the head inclined slightly forward, the cup is filled with the plaster mixture and introduced quickly into the mouth, when it is pressed up slowly and gently (the rear or heel of the cup first, which causes most of the surplus plaster to be forced forward), until the parts are completely

encased and portions of plaster are seen to protrude from all parts of the margins of the cup, otherwise the impression is liable to be imperfect, either on its outer borders or on its posterior palatal face. Immediately after introducing and pressing up the cup, the lip in front should be extended and drawn down over the cup, when gentle pressure, as the plaster is hardening, may be made upon the lip and cheeks, to force the plaster more perfectly into close contact with the outer surface of the alveolar ridge.

It is essential to perfect success in this operation that the cup, after the parts are once imbedded, should be held perfectly stationary until the plaster becomes fixed, as the slightest movement when the plaster is in the act of consolidating will derange the impression and render it faulty. Again, if after the parts are imbedded the operator discovers that they are not sufficiently encased, and the plaster has partially set, no further effort should be made to press the plaster up upon the parts, but the cup should be withdrawn and the operation repeated with fresh plaster.

If the operation has been successfully conducted, the plaster will adhere to the mouth, in most instances, with great tenacity, and it will be necessary to observe some caution in removing it, for, if forcibly detached, injury may be inflicted upon the soft parts by tearing away portions of mucous membrane; or the impression may be badly fractured or otherwise impaired. In addition to the means already alluded to in connection with the method of separating wax impressions from the mouth, resort is sometimes had to the following expedient: The central portion of the cup being pierced with two or three small holes, a blunt-pointed probe is passed at these points through the plaster, before the latter has hardened perfectly, to the roof of the mouth. Into these passages the external air passes and diffuses itself between the surface of the plaster and the palate, when the impression may be readily detached. The writer, however, has succeeded best in detaching impressions in such cases by upward and interrupted traction upon the handle of the cup, which, by depressing the latter posteriorly, more readily permits the introduction of air than by either of the methods commonly employed.

Manner of Obtaining an Impression of the Mouth in Plaster, for Entire Lower Dentures.—The general form of cup used for the above purpose is shown in Fig. 52. This being filled with the

plaster mixture, prepared as described in connection with full upper pieces, is inverted and quickly introduced into the mouth and pressed down upon the ridge until the latter is completely imbedded, being careful at the same time to draw the lower lip away from the cup, and the cheeks outward, in order to prevent any loose tissues from folding in upon the outer borders of the ridge as the cup is pressed to place, thus seriously marring the impression.

It is thought by many operators that better results can be secured by first taking the impression in wax, enlarging the impression thus secured with suitable instruments, and using this as a tray for plaster.

CHAPTER XIV.

PLASTER MODELS.

After an impression of the mouth has been secured in either of the ways mentioned in the preceding chapter, the next step in the process of constructing an artificial denture is to procure from the impression a representation of the parts in plaster. The copy thus secured is called a MODEL, or cast, and if correctly obtained is a true counterpart, or facsimile, of all parts of the mouth represented in the impression.

Manner of Obtaining a Plaster Model from an Impression in Wax or Modeling Compound, for Partial Dentures.—The impression should be first trimmed by cutting away superfluous portions that overhang the borders of the cup, care being taken not to mar any essential part of the impression. The surface imprinted should then be uniformly and thinly coated with soapy water or oil, applied with a camel's-hair brush. This should not be of too thick a consistency, nor applied in too large quantities, as it will collect in the more depending portions of the impression, and, failing to be displaced by the plaster, leave the model imperfect at these points, especially at the coronal extremities of the plaster teeth. The cup is now surrounded by some substance that will confine the plaster and give proper form to the body of the model. For this purpose any material that is easily shaped may be used, as a thin sheet of lead or wax, paper, strips of oil- or wax-cloth, etc.

Before pouring the plaster, if it is desired to strengthen any of the plaster teeth—as those adjoining the vacuities in the jaw, or such as are to be used in adjusting clasps—and thus secure them against accident in handling, adequate support may be imparted to them by placing short pieces of stiff wire vertically in the depressions made in the impression by the teeth, supporting them in an upright position by imbedding one end in the wax or other material in the center of the bottom of each cavity.

When the cup is properly inclosed, a batter of plaster, of some-

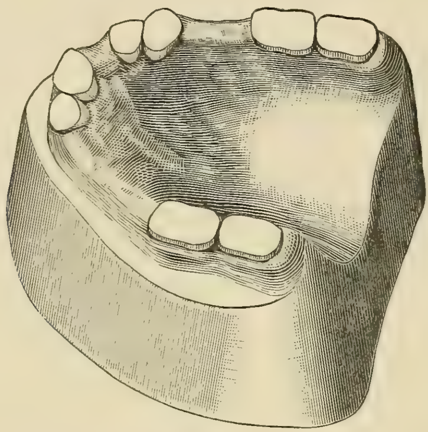
what thinner consistency than that used for impressions, is poured in upon the surface of the wax in sufficient quantity to give to the body of the model a depth of from one to three inches, according to the particular requirements of the case. The plaster should not be poured directly or hastily into the cavities formed by the teeth, but upon points contiguous to them, and from which it should be allowed to run slowly into the depressions, by tapping the bottom of the cup gently upon the table, thus expelling the contained oil or air, and filling them perfectly. When the plaster has become sufficiently hard, any portions overlapping the borders of the impression, and not essential to the form of the model, should be cut away and the two separated by immersion in warm water until the warmth imparted to the model renders the impression sufficiently soft to allow the former to be removed without fracturing the plaster teeth.

The general form of the body of a model is shown in Fig. 58. Where a swaged base is required, the walls, as will be seen, are made as nearly vertical or parallel as will admit of the model being readily detached from the sand in the process of molding; for if made too flaring or divergent, the metallic die obtained from it will be more liable to crack or spread apart under the repeated strokes of a heavy hammer, or to rock under one-sided blows.

During the process of stamping or forcing a metallic base into adaptation to the die—which is a metallic counterpart of the model—the plate, when cut to the exact pattern of the parts to be covered by it, is frequently forced or dragged back toward the heel of the die, and is thus drawn from the teeth at the sides and in front. This displacement of the plate may be prevented by cutting away all of the plaster teeth from the model, leaving, however, enough of them remaining where they unite with the body of the model to form a shoulder to each tooth, as in Fig. 57. In this case the plate should be sufficiently ample in its dimensions partially to overlap the border, when, as it is forced into adaptation, distinct indentations will be made in it, corresponding exactly with the palatal curvatures of the teeth; the portions of the plate covering the cut ends of the teeth are then cut away with plate forceps or other instruments. If, however, the plate is of the exact size required before stamping, one or two plaster teeth

upon each side of the model may be allowed to remain, against the anterior face of which the plate is made to rest, holding it stationary.

FIG. 57.



Manner of Obtaining a Plaster Model from an Impression in Wax or Modeling Compound, for Entire Dentures.—The same general method is pursued in obtaining a plaster model from an

FIG. 58.

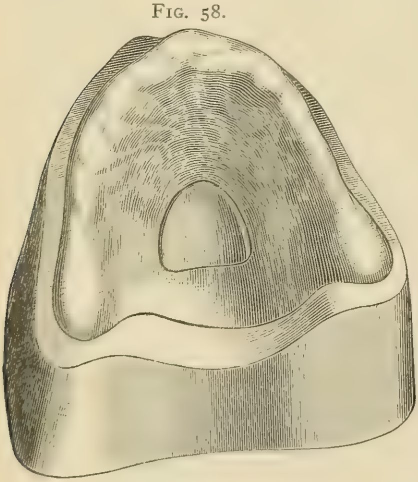
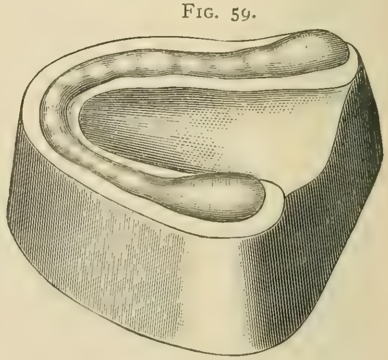


FIG. 59.



impression of either the upper or lower jaw for entire dentures with the substances mentioned, as that employed in partial cases. The general form of these pieces is represented in Figs. 58 and 59.

If it is desired to swage a rim to the plate, forming a groove or socket into which the plate extremities of the teeth are received, the model should be formed in the manner represented in the annexed cuts; in which it will be seen that an abrupt shoulder is formed on the external border of the model of the upper jaw (Fig. 58), but which on the lower (Fig. 59) is extended round the inner border also, as it is desirable, in the latter case, to give a rounded edge to the lingual border of the plate, and which is accomplished in part by swaging in the first instance and afterward by turning the edge down upon the plate with pliers or by other means. The model is prepared by adjusting a strip of softened wax around the border, and cutting away from its upper surface in such a way as to form a groove, the bottom of which shall be on a line with the extreme edge of the base or plate, which should be indicated upon the model with a pencil mark before applying the roll of wax.

Rimmed plates, however, are only required when single gum teeth, or sectional, or entire blocks are employed, or when plate teeth are mounted on a platinum base with continuous gum.

Forming the Air-chamber.—Whenever an air-chamber is to be stamped in the base, the model should be prepared for the purpose before casting the metallic swages. The general form and position of the central cavity or chamber in the arch is represented in Fig. 58. The model may be prepared in either of the following ways: 1. The form of the chamber may be cut from the wax or plaster impression, in which case the plaster will be raised at a corresponding point or points upon the model, and will have exactly the same form and depth as the cavity in the impression. 2. Cover the palatal face of the model with a sheet of wax equal in thickness to the required depth of the chamber, and cut out from this, at the desired point, the form of the cavity; fill the latter with plaster, and when hard remove the wax and trim the raised portion to the proper form. 3. Cut a pattern, of the required form and depth of chamber, from sheet-wax or lead; place it in proper position in the arch, and press down with the fingers or burnisher until it conforms to the contour of the palate; it is then fixed in place either by confining it with a small pin or tack driven through it into the plaster, or by interposing softened wax or other adhesive material between the pattern and model. A small brush

loaded with a varnish mixture passed around the edge of the pattern will insure sufficient adhesion.

The same general method as that when central chambers are formed is pursued in the preparation of the model when it is desired to construct lateral cavities in the plate. The form and position of these on the model will be indicated by inspection of the form of "lateral cavity" plates as exhibited in the chapter on Entire Dentures.

There are other modifications in the form of cavity plates, some of which are obsolete; that known as "Cleveland's chamber" is still in limited use, but does not require a model differing in form from the one described in connection with full dentures with central chambers.

Manner of Obtaining a Plaster Model from an Impression in Plaster, for Partial Dentures.—The surface of the impression in plaster should be first glazed, by applying to it, with a camel's-hair brush, a uniform coating of varnish, to prevent adhesion of the model. Two kinds of varnish are in common use—a transparent and a colored. The former is preferred, for the reason that it penetrates the plaster more thoroughly, giving to it a greater depth of surface hardness, while the latter, if not sufficiently fluid, forms a somewhat superficial incrustation, which is liable to peel off in handling, leaving portions of the model unprotected. Either, however, if properly prepared and applied, may be employed.

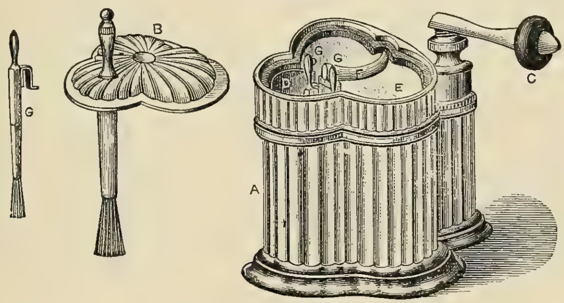
Formula No. 1. TRANSPARENT VARNISH.		*Formula No. 2.* COLORED VARNISH.	
Gum sandarach,	5 oz.	Gum shellac,	5 oz.
Alcohol,	1 quart.	Alcohol,	1 quart.

The sandarach or shellac should first be freed from all impurities by careful picking and washing; they are then added to the alcohol and digested over a moderate heat until thoroughly dissolved. Other substances, as gum elemi, Venice turpentine, etc., have been recommended as additional ingredients, but they are not indispensable, and may be omitted without sensibly impairing the properties of the varnish.

The varnish, or separating fluid, should be kept securely bottled, to prevent evaporation of the alcohol, and keep it free from dust and other foreign substances. For this purpose the "Clo-

ver-Leaf Holder" (see Fig. 60) is probably the most convenient, neat, cleanly, and economical receptacle on sale for that purpose. The body is of glass with nickeled mountings and cover. It contains two compartments, the larger for the varnish, the smaller for the brushes, of which there are three, a large one attached to the lid, and two smaller ones which depend from the partition between the compartments by means of a little hook. Across the main compartment is a scraper to remove surplus varnish from the brushes. The lid is held in place upon a rubber ring with a firm pressure, by means of a rubber wheel attached to a swinging lever. This makes the holder air-tight and prevents evaporation of the varnish. The brushes are specially made for varnish, of fine goat's hair, which is better for the purpose and more durable

FIG. 60.



than camel's-hair. A little alcohol placed in the brush compartment keeps the brushes pliable, and is convenient for thinning the varnish when desirable.

After glazing the surface of the plaster impression with varnish, a thin and uniform coat of oil or soapy water should be applied; it is then enveloped, and the model procured in the same manner as when the other plastic materials are used.

The following method of preparing the plaster impression before it is filled in for the model is recommended by Dr. C. W. Spalding: "After the impression has become hard, coat the surface with a lather of soap and water; wash this off and immerse the model in water. This expels air and avoids liability to porosity of the surface of the model. Again coat the surface with a strong lather of soap and water, and wash off as before, when the impression is ready to receive the plaster for the model. I prefer

this method to varnishing, for the reason that the varnish used is not always of uniform consistency."

In separating the model from a plaster impression, for partial cases, it will be necessary to cut the latter away in pieces, as any attempt to separate the two in the ordinary manner would inevitably break away the plaster teeth from the model. The impression should be chipped away with care, to avoid defacing the model. To provide more perfectly against this accident, it is better to coat the impression with colored varnish, as this will indicate with greater certainty the line of contact or union between the two pieces. Dr. Spalding suggests a simple and effective device for the same purpose, which consists in coloring the water used to mix the plaster for the impression with anilin red. When separated, the model should be trimmed and formed in the manner before described.

Manner of Obtaining a Plaster Model from an Impression in Plaster, for Entire Dentures.—The preparation of a plaster impression of either the upper or lower jaw, for full dentures, and the method of procuring a model therefrom, differ in no essential respect, except in the mode of separation, from the manipulations required when the impressions have been taken in plaster for partial pieces. A model can, ordinarily, where there are no considerable depressions or undercuts on the external face of the ridge, be readily separated, either by taking the model in the hand and tapping the handle of the cup, or by forcing a wedge-shaped instrument between the impression and model at the posterior border. When, however, there are considerable undercuts, such as usually prevail on either side of the median line in front, above and below, or the anterior and middle portions of the ridge are thin, prominent, and overhanging, the application of sufficient force to detach the impression in a body will inevitably fracture such portions of the ridge of the model as are engaged in the contracted spaces. In such cases, the cup being removed from the impression, the latter should be grooved as deeply as possible without marring the face of the model, in such a way that, when the instrument is forced in at suitable points, the impression will be fractured on a line with the grooves, and thus be detached in sections. One groove may be made continuously along a line corresponding with the summit of the ridge, and others extending

at right angles with this to the outer borders of the impression. When these external sections are removed separately by wedging at the extreme border of the impression, the whole central portion will be easily detached. Extreme thinness and prominence of the ridge will most generally be found in connection with the lower jaw, and will require cautious manipulation to avoid accident to the model. If any portion of the model should be defaced, it may be remedied by restoring the contour with plaster. After detaching the model in the manner mentioned, the entire body of it should be glazed and hardened by applying to it a thin and uniform coat of varnish, if it is to be used in obtaining a metallic die. This protective covering will prevent the surface from wearing, render it more pleasant to the touch, facilitate its withdrawal from the sand, and give a more perfect mold. A model may be better prepared for permanent preservation by immersing it for a short time in a solution of carbonate of soda, by which its surface is converted into carbonate of lime and thereby rendered hard and durable; care must be taken not to introduce any of the bicarbonate of soda into the solution.

CHAPTER XV.

METALLIC DIES AND COUNTER-DIES.

A metallic die is a facsimile or transcript of the mouth in metal, and is also a copy or likeness of the plaster model.

A metallic counter-die is a copy of the impression, and is a reversed image of the die and plaster model.

Manner of Obtaining a Metallic Die.—Two general methods are employed in procuring a metallic counterpart of the model: first, by *molding;* second, by a process termed *"dipping."* The first only, however,—being the more practical and more generally used,—will be considered.

Materials Used in Molding.—For this purpose the best material is marble-dust, though other substances, as sand, Spanish whiting, etc., have been recommended. Marble-dust has the advantage of being always ready for use, or nearly so, as it absorbs considerable moisture from the atmosphere to render it cohesive, is cleanly, and gives a smooth and uniform surface to the die. When sand is used it should be fine and even-grained, the best for the purpose being that used by brass-founders. It is prepared by mixing with it sufficient water to render its particles somewhat adherent, so that when portions of it are pressed in the hand and then parted with the fingers it will break away in well-defined fragments. Excess of water should be avoided, as the vapor formed by the molten metal, when poured upon it, will displace portions of the latter and form cavities or blisters in the face of the die; nor should the sand used be too dry, as in that case it will crumble away in detaching the model.

Oil has been proposed as a substitute for water, in which case it is recommended to add one quart of the former to a peck of sand. It is claimed that the sand so prepared is always in immediate readiness for use.

Preparing Model Previous to Molding.—In upper cases, whether partial or full, a shallow groove should be made along

the posterior plate line, so that when the plate is swaged this edge will press firmly against the roof of the mouth. The cast should also be carved at the points where the integument of the palate is soft and yielding. In some cases the center of the palatal portion of the mouth is unusually hard and unyielding; in fact, large, bony prominences are sometimes found; these points should have a thin layer of wax placed over them, so as to relieve the pressure, otherwise the plate would rock, thus interfering with the adhesion and the wearer's comfort. The form for the vacuum-chamber should also be built up with wax or other material, when the cast will be ready to proceed with the molding.

Manner of Securing Mold.—The molding material being properly prepared, the model is placed with its face uppermost on the molding-board and surrounded with a metallic ring. What is known as the Bailey Molding-flask is used by many operators. A common "wagon-box," however, of which two or three sizes should be had, will answer every purpose in ordinary cases. If sand is used, it should first be well sifted to remove the coarser particles, and then filled into the ring, packing it closely with the fingers around and over the model until even with the upper edge of the box. Some care must be observed in the management of the molding material when packing it, for, if made too compact, the vapor formed in pouring hot metal, failing to pass out readily, will be confined within the cavity and cause imperfections in the face of the die; or, if too loosely packed, the fluid metal, when poured into the mold, will, to some extent, permeate the pores of the sand or other material, and render the face of the die rough and imperfect.

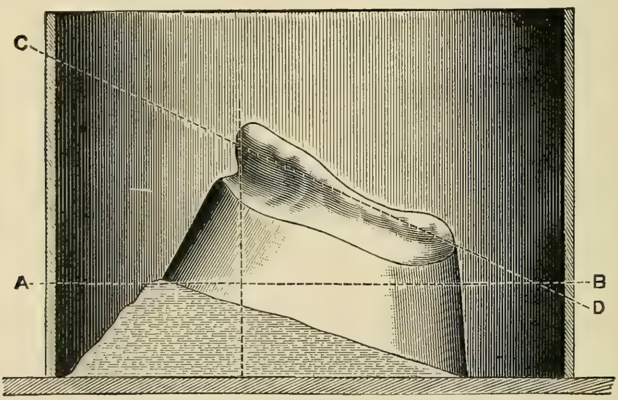
Manner of Withdrawing the Cast.—After the sand has been well packed, level off the surface with a rule, lift the flask or ring with its contents from the bench, turn it over carefully, and lay it down with the bottom of the cast up. Now run the point of a tack or the small blade of a knife into the center of the cast with a few gentle taps from the hammer. Grasp the knife or head of the tack firmly between the thumb and fingers, and with a small hammer distribute a few gentle taps over the surface of the cast. If the cast cannot then be withdrawn, continue the process and at the same time distribute a few gentle blows over the edge of the molding-ring, when it will usually be found that the cast can be

readily lifted out. All these manipulations must be very gentle or the cast may be tilted or rocked in the sand, and thus make a false impression.

Another method of removing the cast from the sand, usually given in the text-books, is to reinvert the ring and contents, hold it above the table, and dislodge the cast by tapping it gently underneath. The writer would, however, in nearly all cases reject a mold from which the cast had fallen out by its own weight.

Manner of Molding where Undercuts are Present.—Where we have an overhanging alveolar ridge producing a slight undercut, the front of the cast may be raised by first building an inclined bed of the molding material, and resting the cast upon its highest

FIG. 61.



point with the heel upon the molding-tray or table, as is shown in Fig. 61. It can then, in ordinary cases, be readily withdrawn.

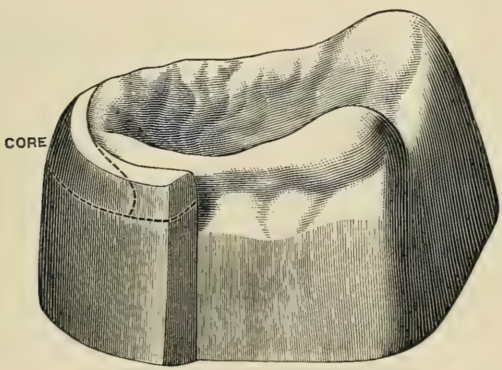
Molding with Cores.—Where the undercuts are too great to be overcome by the method just described, what is known as core-molding is employed. First set the cast on some smooth surface; oil at the site of the undercut; mix plaster and asbestos, or plaster and marble-dust, equal parts. When dry, apply the mixture of proper consistency to the front of the model, from the bottom up to the edge of the alveolar line, spreading it on both sides so as entirely to fill up the depression, making the lower edge ½ of an inch thick, and sloping off toward the alveolar ridge (Fig. 62). When this has hardened, separate it from the model, and draw the top of

it over sand-paper to obtain a flat edge, and let it dry. Readjust this front piece to the model; procure a mold in sand or other material, in the usual way; place the extra piece or core back in its proper position in the mold, and proceed to cast for the die. After the mold is secured, the core is removed from the plaster model, replaced in the mold, and the metal poured.

The Hawes Flask.—The difficulty mentioned above may also be overcome by employing the sectional molding flask invented by Dr. G. W. Hawes, the several parts of which are represented in Figs. 63, 64, and 65.

Fig. 63 represents the lower ring, composed of three movable pieces, with flange extensions that project in toward the center.

FIG. 62.



When used, this portion of the flask is closed and the sections kept in place by pins passing through the joints. Inside of this ring the model is placed face upward, the ridge extending a little above the upper plane of the ring. Sand, well sifted, is then packed in around the model on a level with the most projecting points on the outside of the ridge, as indicated by the dotted line in Fig. 65. The surface of the sand should be trimmed smoothly, and should be cut squarely and at right angles with the ridge to prevent the sand from breaking away when the model is withdrawn. Very finely pulverized charcoal, contained in a loose muslin bag, is now sifted over the exposed surface of the sand to prevent the next portion contained in the upper ring from adhering. The plain ring (Fig. 64) is then placed over the one contain-

ing the model, and is filled with sand well packed over the face of the die. The upper ring is now carefully lifted from the lower one on a line with the pins, thus separating the two portions of sand, and again exposing the uncovered face of the model. One of the pins should then be drawn from the lower ring, the sections of the latter carefully unfolded, and the model withdrawn, when the ring may be again closed and confined by replacing the pin. The upper ring is then readjusted in its proper relation to the lower one, the flask inverted, when the mold, if the process has been accurately conducted, will be found perfect.

In obtaining a mold from the model of a lower jaw, but little difficulty will ordinarily be experienced in obtaining it perfect in

Fig. 63.

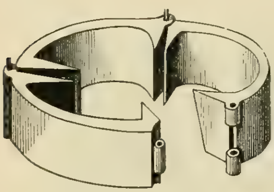


Fig. 64.

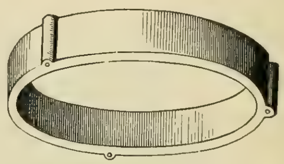
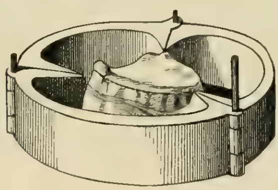


Fig. 65.

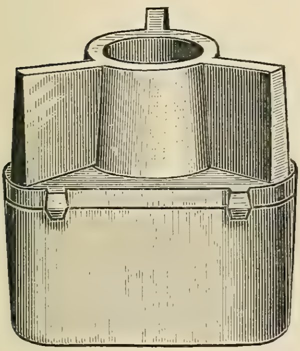


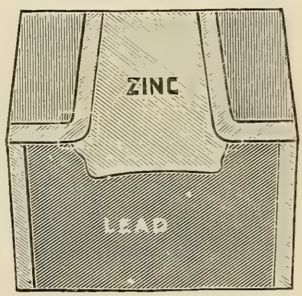
the manner first described. The depressions at the posterior and inner border of the ridge are the points most liable to drag or displace the sand, and when the latter occurs, the surplus metal in the die at such points must be cut away with suitable instruments; or the cavities in the model may be so filled out with wax before molding as to permit the ready separation of the model without displacing the sand, in which case, also, it will be necessary, afterward, to trim the redundant metal from the die.

The Lewis Molding-flask.—This form of flask, introduced by the Buffalo Dental Manufacturing Co., is an improvement upon the Bailey Flask for making dies; the top part, which forms the

zinc die, being entirely new in shape and purpose. By the use of this flask, the metal in the die is concentrated above it, so that it has no outside bearing upon the counter-die; thus overcoming what is to many dentists a serious objection to dies produced with the ordinary flasks or rings, viz., the bearing of the die upon the counter, outside of the model, preventing the driving of the former into the latter as it yields in swaging, unless the method suggested by Dr. Broomell on page 169 employed. In dies produced by the Lewis Flask, the bearing of the die upon the counter is limited to the model, and a more perfect adaptation can be secured between it and the plate. With this flask a thin model can be used, at the same time all the advantages of the old-fashioned, thick, or built-up model secured.

FIG. 66





When this form of flask is employed, the procedure is as follows: A thin plaster cast should be trimmed to give proper draft at the edges; varnish and dry thoroughly. Before proceeding to mold, dust it with a little finely-powdered charcoal, shaking off all that does not adhere. Invert the top or winged section of the flask, fill its conical cavity with sand, leaving it a little high, and press the back of the model firmly upon it, to secure a solid foundation and prevent rocking. Place the ring in position, and sift the sand into it, ramming it down carefully. Strike off the surface of the sand level with the top of the ring. Reverse the flask, holding the sections together securely; then remove the winged section and draw the model. Fill the depression in the sand with the molten metal; then place the upper section of the flask in position —the sand having previously been knocked out of it—and complete the pouring of the metal. When the die has cooled, smoke

its exposed surface, and replace it in the winged part of the flask; knock the sand out of the ring, place it in position, and fill with the counter-die metal.

The Pearsall Molding-flask.—This form of molding-flask, as Mr. Booth Pearsall, the designer, says, is intended to remove some of the many defects found in zinc dies as commonly made by dentists. The molding-plate (Fig. 67) is circular, and has on its upper surface four concentric grooves and four projections or tabs. The grooves hold the sand, and make so many dikes or obstructions to prevent the hot metal from running out between the molding-plate and the sand. The grooves also serve to guide the workman in correctly centering or excentering the position of the model, so that the cone or striking part of the die will come where most strength is required—in other words, where the heaviest hammering is to be done. On the under side of the molding-plate are four webs or feet (C, Fig. 69), running from the circumference of the plate to the conical aperture A, in the middle, by which the truncated cone to be hammered upon is molded. The object of these feet is to make the molding-plate strong enough to bear rough usage, and of sufficient weight to prevent it from being floated off the sand-mold by the weight of the molten metal as it is poured in, as well as to form steady feet for the plate to rest upon on the molding-table.

The sand-ring is of strong hoop-iron, and should fit easily and truly on the grooved surface of the molding-plate next to the projections or tabs.

When molding is to be done, the molding-plate is placed in the sand-drawer or on the table, grooved side upward, and on it the shallow plaster model (from ¾ to one inch deep, as may be desired) (Fig. 67), in such a position as to bring the cone-shaped aperture where most strength is required in the die. The iron sand-ring is then put on the molding-plate (Fig. 68), and sand is packed in in the usual way. When the packing is finished, the iron ring full of sand, with the molting-plate, are turned upside down (Fig. 69). The molding-plate is then removed, exposing the model, which is withdrawn by the aid of a point and hammer in the usual way.

The mold having been examined, and any loose particles of sand blown out of it, zinc sufficient to barely fill the mold is

Fig. 67.

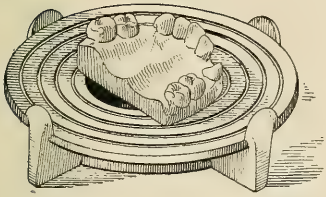


Fig. 68.

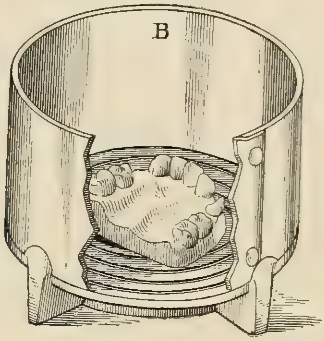


Fig. 69.

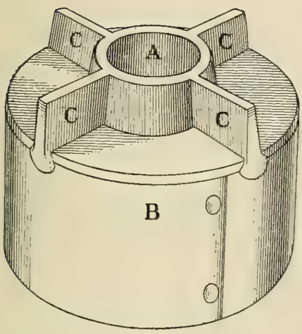


Fig. 70.

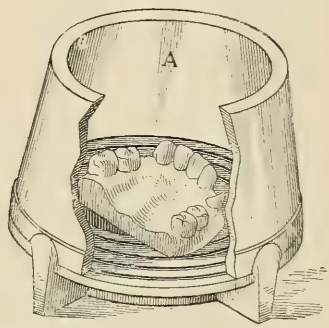
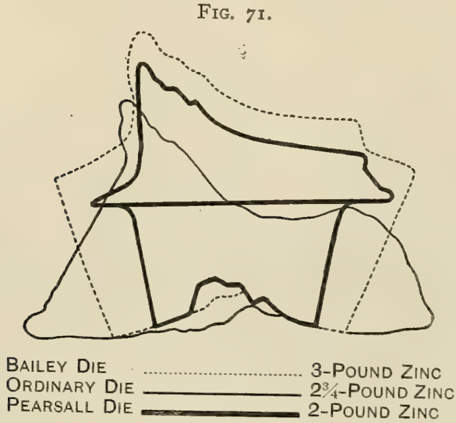


Fig. 71.



poured in, the molding-plate *slightly heated* is put over the mold, and the remaining zinc poured into the aperture to make the cone-shaped end of the die. Of course, if the sand-mold is over-filled with zinc in the first instance, there will be difficulty in placing the molding-plate on the sand-mold, but this is easily avoided.

To make a counter-die, the molding-plate, zinc die, and a counter-die ring are arranged as in Fig. 70, sufficient sand being packed about the die to give the depth of counter-die required.

In use, the swaging of a plate will be found more certain and accurate, because of the ease with which heavy blows can be struck on the truncated cone, and the hollow formed in the center of the cone by the cooling of the zinc is really a source of strength, so far as construction is concerned. The cone-shaped end, with the model projecting over it, enables the die to be held in a vise in such a way that blows struck on the palate or teeth of the model will not cause it to slip in the jaws of the vise. The die thus has a steady bearing, forming a great contrast to the slippery and uncertain hold of the ordinary form of die when placed in a vise to be filed or hammered. It can also be easily and quickly turned and secured in any desired position by opening and instantly reclosing the jaws of the vise, whereas neither the Bailey nor the ordinary form of die can be secured in a vise with the same certainty, precision, or rapidity.

Attention may also be directed to the ease with which blows can be struck outside the cone on the shoulder formed by the projection of the mold, and such blows are often of the greatest service in certain cases, instances of which will readily suggest themselves.

The advantages, as summed up by Mr. Pearsall, are as follows:

1. The shallowness of the model required, and the consequent saving of time in drying it.

2. The ease with which a shallow plaster model can be removed from the sand as compared with a deep one.

3. Saving in the amount of zinc to be melted. As zinc deteriorates by constant melting, this is important, and a supply of zinc ought to go further in the constant use of the smaller dies.

4. The great increase of strength, owing to the improved construction of the die, aided by the cooling of the zinc.

5. The choice offered to the workman in placing the strength

or blow-resisting cone, where it is needed to resist heavy hammering.

6. The ease and rapidity with which the new form of die can be secured in any position in the ordinary vise.

7. The precision of the blow secured by the use of the cone-shaped end of the die.

Diagram No. 5 (Fig. 71) shows sections of the same model used as a die in the new method, the usual method, and that invented by Bailey; but only a comparison of the actual dies can convey an adequate notion of the advantages of the new form.

Preparing Cast for Mold, for Partial Dentures.—A die is more readily and accurately obtained from a model for partial dentures by cutting away the plaster teeth, as before described. The displacement of sand where the ridge overhangs will, as a general thing, be unimportant in these cases, as the base seldom more than partially overlaps the border.

When whiting or marble-dust is used in molding, it is generally unnecessary to mix water with them, as the moisture which they absorb from the atmosphere will give to them the proper consistency.

Preparing and Pouring Metal for Dies.—Having obtained a mold in either of the ways mentioned, the metal designed for the die should be melted and poured carefully in upon the more prominent portions on the face of the former. If the metal is raised much above its fusing-point, or the sand is quite damp, the former should be poured very slowly into the mold. It is better, however, that the sand should be partially dried before pouring the metal, and the die cast, on the instant of the metal becoming sufficiently fluid. An observance of these precautions will protect the sand from the overaction of heat, prevent ebullition of the fused metal from the too rapid decomposition of the water in the sand, will give a smoother face to the die, and secure the metal or metals from undue waste by oxidation. The opinion is entertained by some, that greater shrinkage of the die occurs when the metallic substance of which it is composed is poured at a temperature much above its fusing-point; the fallacy of this is made obvious by a moment's reflection, as a simple example will show that any change affecting the face of the die, as a consequence of contraction, can only occur in the metal between its

point of solidification or liquefaction—for they are identical—and its working temperature. Zinc, for example, melts at 773°. Now if its temperature be raised to 1200°, it will remain fluid until it reaches 773°, and in passing through the intermediate degrees of heat, it will, in obedience to gravity, adapt itself perfectly to all parts of the mold; and this perfect continuity of the two surfaces will remain unaffected by the contraction of the metal until the latter commences to "set" or solidify, after which, and not until then, the zinc begins to part from the face of the mold by contracting upon itself between 773° and the mean temperature of the air. So far as any change, by contraction, in the face of the die is concerned, therefore, it is obviously immaterial whether the zinc be poured on the instant of melting or at 1200°; the result will be the same in either case.

The Franklin Mold.—The author is indebted to Dr. B. W. Franklin for the following method of securing metallic dies and counters by a process which greatly facilitates the operation and insures accurate and satisfactory results: "I take all impressions, full and partial, in plaster. A small hole, less than $\frac{1}{16}$ of an inch, is drilled through the highest point of the palatal surface of the impression, through cup and all; into this place two or three broom splints, cutting them off even with the surface of the plaster, to allow any vapors to pass off. I sometimes smoke the surface of the impression. Around the impression place sufficient putty to form a ring the size and height required for the die. Into this pour, at as low heat as is consistent with the mobility required for sharp castings, the bismuth alloy known as Sir Isaac Newton metal, or, which is better in some respects, eight parts bismuth and four parts each of tin and lead—the latter composition being a little harder. If a little judgment is exercised in pouring either of the above alloys, a perfect die will be secured from moist plaster impressions without any drying. As the bismuth is expansive and the alloy is hard and somewhat brittle, I run only a thin casting, not more than $\frac{1}{2}$ of an inch in thickness, over the highest portion of the impression. I have cast-iron or brass heads made, $3\frac{1}{4}$ inches in length, 3 inches in diameter at the large end, and 2 inches at the other; the large end is flat, and well coated with common tinman's solder. This head is heated until the solder begins to soften; it is then placed in a pan or other convenient vessel, and the die, face side up, is placed upon the tinned surface. When the die begins to melt, and perfect union

is secured, cold water is dashed upon the die and head; and thus we have a sharp die, with an iron head, to sustain the force of the blow in stamping the plate, and by this means preventing any spreading of the face of the die or liability of breaking in the process of swaging.

"I now take sheet-lead of the thickness of about No. 24, standard gage, and adapt it to the face of the die by means of a wooden mallet or burnisher, or other convenient means. Trim the lead plate to the size required for the plate to be stamped; when the lead plate is nicely fitted, remove it carefully from the die and place it in a ring or narrow molding-flask, the palatal side up; now gently stamp molding sand into the plate and flask, up level with the edges of the flask; then reverse the flask and cut the sand away *clean* for ½ of an inch or more down to the edge of the lead plate all around. Around the plate place a common molding-ring, sufficiently large to form the counter, which is made by pouring melted tin or lead (or any alloys of these metals) on to the lead plate, being careful not to run the metal so hot as to melt the lead plate. When the counter is cool enough to handle, the adhering sand is brushed or washed away; the die is then placed into the bed or counter, and, with a moderate-sized hammer, give one or two sharp blows to bring the die and counter together. In swaging gold plates, two, three, or more dies may be required; these may be made either by running the die metal into the impression (if not broken) or by running into lead plates, gotten up as before described, reserving, of course, the first die and counter for the final swaging of the plate. I have gotten up a die and counter from the impression, with the aid of an assistant, in the foregoing manner, in twelve minutes. I usually get out my die immediately after taking the impression; adapt a wax or gutta-percha plate to the die, and get the articulation before the patient leaves the office."

In the act of contracting, the central portion of the die, being the last to solidify, is gradually drawn toward the periphery, forming, when the contraction is completed, an excavation of greater or less depth in the center of its base, a form unfavorable to an equal distribution of the force applied in swaging, and greatly increasing the danger of distorting the face of the die by cracking or spreading, especially when zinc is used. To concentrate and equalize this force is a matter of the first importance. The liability to such an accident may, to some extent, be avoided

by placing on the die a cone-shaped cap of any hard metal, as zinc, brass, or cast-iron. This, however, while it provides against one-sided blows of the hammer, affords only a partial remedy, since the same danger of spreading the die exists, in consequence of the cap resting on the outer border of the base of the die, with no central bearing whatever. To equalize the force perfectly, the cone-shaped metal cap should be incorporated with, and form part of the body of the die itself. This is partly, if not wholly, accomplished by Dr. Franklin's expedient.

Counter-dies.—A counter to the die is generally obtained directly from the latter. The die is placed, face upward, upon the molding-table, and sand, prepared as in molding, built up around it, leaving only the ridge and palatal face exposed. It is then encircled with a cast- or sheet-iron ring two or three inches deep, its edge imbedded in the sand to prevent the escape of the fluid metal; into this the metal for the counter is poured until nearly or quite full.

The metal commonly employed for the counter is lead, although other substances, as tin, type-metal, some of the more fusible alloys hereafter to be mentioned, etc., are sometimes employed. When the counter is taken by pouring the metal or metals composing it upon a die fusing at a low heat, some caution should be observed lest the two pieces adhere by partial fusion of the die. In such cases the surface of the die should be well protected with lamp-smoke or whiting; the lead should be poured at the lowest practical temperature, and the conduction of heat facilitated by surrounding the die with a heavy cast-iron box or ring.

During the process of forcing a plate into adaptation to the form of the mouth with swages, it not infrequently happens that the marginal portions of the former become wedged or immovably fixed between the outer border of the die and corresponding portions of the counter before its central portion is forced into contact with the palatal surface of the former, thus rendering it difficult to conform the plate accurately to the parts without the application of sufficient force to deface or otherwise mar the form of the die. In such cases the central portion of the plate may be first swaged with a *partial counter,* which is made to receive only the palatal portion and upper surface of the ridge of the die. This method, as practised and described by Dr. I. N. Broomell, of the Pennsylvania College of Dental Surgery, is as follows:

"**Progressive Counter-dies.**—It being desirous, in swaging a plate, to have the palatine portion forced into position at the beginning, the *first* counter-die should be formed as represented in Fig. 72. To accomplish this the sand must be built entirely over the ridge, allowing only the palatine portion of the die to be ex-

FIG. 72.

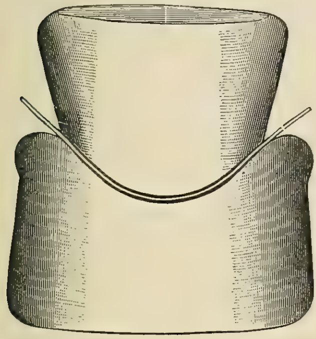


FIG. 73.

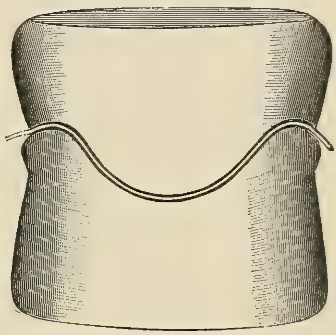
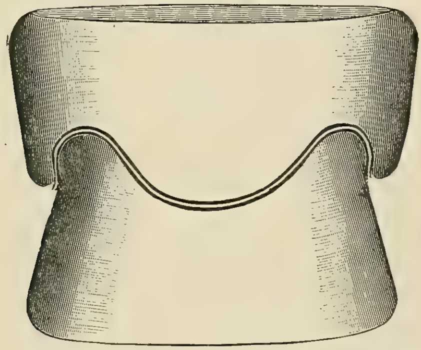


FIG. 74.



posed. The *second* counter-die should extend just beyond the center of the ridge, as shown in Fig. 73, and the *third* or final counter may be formed in the usual manner, see Fig. 74. By the judicious construction of this series of counter-dies, more satisfactory results are obtained, and much needless use of the horn mallet dispensed with. It will readily be observed that a counter-die, formed as represented in No. i (Fig. 72), will drive the center of the plate into position without the usual resistance experienced in using the ordinary counter. The use of No. ii (Fig. 73) will gradually start the plate over the ridge, and No. iii will readily complete the process."

As before remarked, preference is usually given to lead in the formation of a counter-die, mainly on account of its greater softness. This property in a counter is practically important. In the process of forcing a metallic plate into adaptation to the mouth, partial displacement or yielding of either the die or counter, or of both, necessarily occurs, and it is scarcely necessary to remark that whatever change of form is produced should take place wholly in the counter, otherwise deformity of the die must ensue.

Essential Properties of a Die.—There are certain properties which it is indispensable that a metallic die should possess in order to answer fully the requirements of the dentist.

1. A die should be sufficiently *hard* to resist any necessary force applied to it in stamping the plate without suffering any material change in the form of its face, by which latter term is meant that portion of the die with which the plate is brought in contact. This property is most indispensable in those cases where the arch of the mouth is very deep, the rugæ prominent and sharply defined, and where the alveolar ridge is marked by angular and abrupt prominences and depressions. In such cases, if the die is not sufficiently resistant, the points most prominent upon its face will be bruised or battered down, while the plate will fail to be forced perfectly into the cavities or depressions, and its coaptation to the mouth, to that extent, rendered faulty. The case in which a less degree of hardness is admissible is where the arch of the mouth is broad and shallow, the rugæ imperfectly defined, and the ridge regular and symmetrical. The conformation of the mouth, therefore, will, in respect to the property of hardness, admit of some latitude in the choice of the metal or alloy employed in the formation of a die.

2. Another important property of a metallic die is *non-contraction,* so far, at least, as this is attainable. Inasmuch as the successful adaptation of the plate depends, in a great measure, upon an accurate representation of the precise form of the mouth in the die, it is of the first importance that the latter, other requisites being secured, should be composed of some metal or metals having the least possible contraction in cooling. Contraction is, in varying degrees, common to all metals exposed to a decreasing temperature, and it is impossible, therefore, to obtain a perfectly

faultless copy of the mouth in metal. Fortunately, as well for the expert as the unskilled manipulator, the unavoidable shrinkage incurred is partially or wholly compensated for, by the expansion of the plaster model and the yielding condition of the soft tissues of the mouth, but under no circumstances should the accommodation afforded by the condition last mentioned encourage negligence or unskilfulness in the use of all available means necessary to secure the most accurate adaptation of the base. Ordinarily, a moderate degree of contraction will not materially impair the fit of a plate; on the contrary, in the case of the upper jaw, it sometimes favors its adhesion and retention in the mouth. Cases, on the other hand, frequently occur where the least practicable amount of shrinkage, even at the partial sacrifice of other properties, becomes indispensable in the die.

3. A third important requisite of a die is *fusibility*. Aside from the convenience incident to the use of metals which fuse at a low heat, there is another consideration favoring this property of more practical importance. It is well known that all metals expand by heat and contract by cold. In obedience to this law, metals fusing at a high heat suffer a greater aggregate contraction than those melting at a lower temperature, and, as between two metallic bodies of equal dimensions, liquefying at different temperatures, the difference in contraction will correspond exactly with the difference in the number of degrees through which each passes from the point of solidification to the mean temperature of the air, allowance being made for the difference in their ratios of contraction. The difference in the contraction will be somewhat modified by that in their ratio of contraction, but it will always be found that the more fusible metals have the least aggregate shrinkage whenever any considerable disparity exists between their fusing-points. It is in accordance with the principles here set forth that the more fusible alloys, some of which melt at remarkably low temperatures, are employed whenever it is important to obtain a die as nearly the exact counterpart of the model as possible.

4. Finally, a die should be sufficiently *cohesive* to resist the repeated blows of a heavy hammer without parting or cracking. Many metals, as antimony, bismuth, etc., in other respects suitable for dies, are objectionable on account of brittleness. But it must not, therefore, be inferred that all metals that are denom-

inated brittle are inadmissible for this purpose; for zinc, which in its ordinary condition is ranked as a brittle metal, and type-metal, which is always so, are in no danger of being forced asunder or of suffering displacement when in the compact form of a die, provided the force used in swaging is judiciously applied, or proper form and sufficient depth are given to the body of the die.

To recapitulate briefly: A die should be formed of some metal or alloy that has a surface hardness sufficient to resist compression; that fuses at a low temperature; that does not, in any material degree, contract in the act of cooling, and whose particles adhere with sufficient cohesive force to maintain perfectly its integrity of form under the hammer. Any one or two of these properties are readily attainable in the same die, but no one known metal or alloy combines all of them perfectly. Thus either cast-iron, brass, bronze, or cannon metal would form an excellent material in respect of surface hardness, and in the compact form of a die would be sufficiently cohesive, but few enjoy convenient facilities for melting them; besides, their great contraction, consequent upon their high fusing-point, would render their employment entirely inadmissible. Again, certain alloys, as those composed of lead, tin, and antimony or bismuth, are eminently suitable on account of their ready fusibility and comparative exemption from shrinkage, but they gain these properties at the expense of that degree of hardness necessary to resist compression. Tin, in its uncombined state, is ordinarily sufficiently fusible, tenacious, and non-contractile, but is too soft and yielding when forcibly compressed. Antimony and bismuth are sufficiently hard, fusible, and non-contractile, but are objectionable on the score of extreme brittleness.

Any metallic substance that combines most perfectly the several properties referred to is, therefore, best adapted to the necessities of the mechanical operator, and experience has almost universally accorded preëminence in this respect to zinc. It presents a more resistant surface to the blow of a hammer than either copper or brass, three times more so than that of tin, and more than double that of type-metal. As it usually occurs in commerce it may be classed as a brittle metal, but when annealed it is tough and malleable. It melts at a heat (773°) which may be readily commanded, and contracts but little in cooling. The late Pro-

fessor Austen demonstrated by actual experiments that an average-sized zinc die measuring two inches transversely contracts $\frac{27}{1000}$ of an inch from outside to outside of the alveolar ridge, being equivalent in thickness to three leaves of this volume. Professor Austen remarks: "In the first case (upper jaw) the plate would 'bind,' and if the ridge were covered by an unyielding mucous membrane it would prevent accuracy of adaptation. In the second case (under jaw) the plate would have too much lateral 'play,' and consequently lack stability. Again, in a moderately deep arch, say ½ of an inch in depth, the shrinkage between the level of the ridge and the floor of the palate will be nearly $\frac{7}{1000}$—rather more than one leaf. In the deepest arches this shrinkage becomes a serious difficulty; in the shallower cases it is not of much moment, as there is no mouth so hard as not to yield the $\frac{1}{1000}$ or $\frac{2}{1000}$ of an inch."

As before stated, a moderate degree of shrinkage in the die may, in certain conditions of the mouth, practically favor the adhesion and permanent retention of a plate applied to the upper jaw. The conditions alluded to, and which prevail in a greater or less degree in all cases, are soft and yielding ridge, and comparatively hard and unimpressible palate. Now, if in the first instance the plate is swaged into uniform contact with all parts of the jaw, it will be readily perceived that if pressure is made over the ridge on one side the latter will yield, while the central portion of the plate, meeting with a fixed point of resistance at the floor of the palate, will "ride" upon the latter, and thus throw the plate from the ridge on the opposite side of the jaw. If, however, a space equal to one or two thicknesses of the plate exists between the latter and the roof of the mouth, as a consequence of contraction in the die, the plate, as it is carried against the palate in the act of exhausting the air from beneath it, will, at the same time, forcibly compress the ridge, securing thereby a more resistant basis along the border, and providing more certainly against displacement of the base on the application of forces brought to bear upon it in mastication.

The extent to which the shrinkage of a die may be admitted in any given case will depend partly upon difference in the conditions heretofore mentioned in the soft parts of the mouth, and in part, also, upon the general configuration of the jaw. In a me-

dium-sized mouth, with a depth of say ½ of an inch to the arch, a moderately soft ridge and resisting palate, the shrinkage incident to zinc will be unimportant, and in many cases will be advantageous. If, however, the vault is very deep, even though there be a yielding ridge, the unavoidable contraction of a zinc die will throw the plate so far from the arch as to render it difficult for the patient to exhaust the atmosphere from between it and the floor of the palate, and even when the latter is practicable, the plate will bind with such force upon the outer border of the ridge as not only to produce pain and irritation of the compressed parts, but the resistance afforded at these points will be sufficient, in many cases, to break up the adhesion, and force the plate from the palate. Again, as an extreme case, if the ridge and palate are somewhat uniformly unyielding, and the palatal vault is at the same time very deep, a zinc die can only be made available in bringing the base as nearly into adaptation as possible, after which the operation may be completed with a swage having a less degree of shrinkage, and which, as a mere finishing die, need not necessarily be so hard as zinc.

In conforming a plate to the lower jaw, the die should be as free as possible from contraction in all cases. The greatest shrinkage in such cases will be between the posterior extremities of the ridge, giving too much lateral play to the plate; in addition to which the posterior and inner edge of the base, projecting outward from the ridge, will obstruct the free action of the tongue, while the latter will tend to lift it from the ridge and render it unstable. These conditions may be partially remedied by turning the edge of the plate in against the ridge with pliers; but this expedient should never be resorted to in any case whenever it is practicable to secure a correct adaptation by swaging.

In all cases in which a zinc die fails to bring the plate into proper adaptation to the parts, either of the following metallic compounds may be used to complete the process after partial stamping with zinc.

Type-metal.—Lead, five parts; antimony, one part. Fuses at 500°; contraction less than one-half that of zinc; more compressible than the latter and very brittle.

Babbitt or Anti-friction Metal.—Copper, three parts; antimony, one part; tin, three parts. First fuse the copper, and then

add the antimony and tin. Melts at a moderately low heat; contracts but little; is brittle, but may be rendered less so by adding tin.

Zinc, four parts; *tin,* one part. Fuses at a lower heat, contracts less in cooling, and has a less surface hardness than zinc.

Tin, five parts; *antimony,* one part. Melts at a lower heat than either of the preceding alloys; contracts but slightly in cooling; is harder than tin and sufficiently adhesive. It is readily oxidized and should be poured as soon as melted.

Fusible Alloys.—The following tabular view of the more fusible alloys, the respective properties of which are deduced from actual experiments, was given by Professor Austen in a paper on "Metallic Dies." * Zinc is introduced into the table for the purpose of comparison.

	Melting-point.	Contractility.	Hardiness.	Brittleness.
1. Zinc,	770°	.01366	.018	5
2. Lead, 2, Tin, 1,	440	.00633	.050	3
3. Lead, 1, Tin, 2,	340	.00500	.040	3
4. Lead, 2, Tin, 3, Antimony, 1,	420	.00433	.026	7
5. Lead, 5, Tin, 6, Antimony, 1,	320	.00566	.035	6
6. Lead, 5, Tin, 6, Antimony, 1, Bismuth, 3,	300	.00266	.030	9
7. Lead, 1, Tin, 1, Bismuth, 1,	250	.00066	.042	7
8. Lead, 5, Tin, 3, Bismuth, 8,	200	.00200	.045	8
9. Lead, 2, Tin, 1, Bismuth, 3,	200	.00133	.048	7

In commenting on the preceding table, Professor Austen observes: "The last column contains an approximate estimate of the relative brittleness of the samples given. As in the other columns, the low numbers represent the metals, so far as this property is concerned, most desirable. Those marked below five are malleable metals; those above five are brittle; zinc, marked five, separates these two classes, and belongs to one or the other, according to the way in which it is managed." Allusion is here made to the process of annealing zinc, which has already been alluded to when considering the latter metal in the former part of the work. The special method employed is thus described by the author already quoted: "The simplest way to anneal a zinc die is to place it in the melting ladle with about a tablespoonful of water, removing it in thirty seconds after the water has boiled

* *American Journal of Dental Science,* vol. vi, page 367.

away. If the fire is a very hot one, remove it immediately on the disappearance of the water. It will often happen that the die is annealed in the process of taking the counter-die. This will more certainly occur when Nos. 7, 8, or 9 (see table), are used for the counter. For example, take tin, using a mass twice the size of the die; should it be heated to 540° (100° above melting-point), it would not, allowing for loss of heat by radiation and contact with the cast-iron ring (if one be used), heat the zinc beyond 330°. Lead, cast as cool as it could possibly be poured, unless in a very heavy ring (such as a 'cart-wheel box'), or in quantity too small for a well-shaped counter, would be apt to raise the zinc at least 400°, and so impair its malleability, whilst, if poured as hot as many are in the habit of doing, the zinc will remain as brittle as when first cast."

The Parker Swaging Device.—This device for swaging dental plates (Fig. 75) consists of two parts: First, a cup made of cast-iron from 3 to 3½ inches in diameter, and 1½ inches in depth, and a "plunger" or "follower," turned to fit the inside of the cup, with a concussion block in the upper end. The lower edge of the plunger is a concave flange so formed that when forced into the cup the contents of the cup will be forced toward a common center. Shot is here employed as the counter, the finest obtainable, No. 12 being the best.

In using this device, first prepare, in any suitable manner, a thin metallic model, ¼ of an inch in thickness over the palatine arch is sufficient; over this "rough swage" the metallic blanks with a horn mallet, or in any suitable way, until the edges are brought close to the model; this is to prevent the shot, or other material used, from passing under the plate. Wrap the model and plate with a few thicknesses of tough manilla tissue-paper; this will keep the shot from getting under the plate, and prevent "leading." Fig. 76 shows the device open, ready to have the model introduced.

When this is done, pour a layer of shot into the cup, sufficient to give the model an even bearing; place the model and plate in the center, and fill up with shot until both are just covered. Now insert the plunger, and be sure that it rests squarely upon the shot, for if it pinches or binds in the cup, and is then hammered upon, it will be almost certain to fracture the cup, while if the

follower rests entirely on the material in the cup, it will be driven downward and inward, no lateral strain developing. The cup must stand upon an anvil or some other smooth, solid surface, while the hammering is being done. Any weight of hammer may be used—the heavier the hammer the fewer the blows necessary—until the shot is thoroughly condensed; then open and pour the contents out of the cup. If, on examination, the edges of the plate are not in close contact with the model, bend them down carefully with pliers, replace them in the cup and reswage until

Fig. 75.

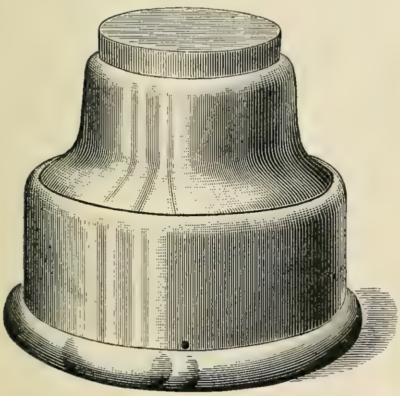
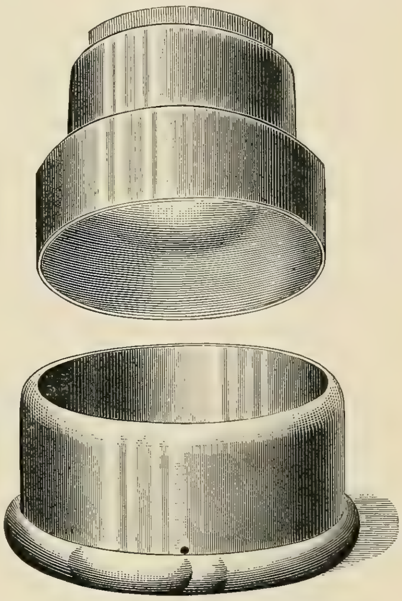


Fig. 76.



the plate fits the model perfectly. The pressure is so evenly distributed that no amount of hammering will distort the die, and if desirable, after the plate is well fitted to the metallic model, it may be swaged over the original plaster cast.

This method can also be employed to good advantage in reswaging an ill-fitting plate, with the teeth on or off, by securing a new impression, trimming or carving model as the case may indicate; then, adjust plate to the plaster model and swage upon it.

CHAPTER XVI.

PARTIAL DENTURES RETAINED IN THE MOUTH BY MEANS OF CLASPS.

Introductory Remarks.—The almost unlimited modifications in the form of substitutes designed to supply the loss of a portion only of the natural teeth, and the difficulties oftentimes incident to a harmonious arrangement of the teeth of replacement, as well, also, as the impracticability of always securing a perfectly satisfactory and efficient antagonism or closure of the artificial with the natural organs, frequently surround this process with peculiar embarrassments, and often render their successful application extremely difficult. They will, accordingly, be found to demand of the operator the exercise of greater skill, ingenuity, and discrimination than are usually required of him in the construction and application of entire dentures.

Certain general and characteristic forms of substitutes of the kind under consideration derive their distinctive character from the means employed in fixing or retaining them in the mouth. These means of retention may be classified as: (1) Clasps attached to the remaining natural teeth; (2) atmospheric pressure and adhesion.

Observations on the Use of Clasps.—Clasps or metallic bands have been long and very generally employed as a means of retaining parts of sets of teeth in the mouth, and are still used, to a limited extent, for that purpose by many practitioners. When these appliances are skilfully adjusted, and all the conditions pertaining to the mouth and remaining natural teeth are favorable to their application, they afford a certain, permanent, and satisfactory means of supporting partial dentures, and may be employed, under such circumstances, with comparative safety to the natural organs. When it is remembered, however, that in a lamentably large proportion of cases, clasps are carelessly or unskilfully formed and fitted to the teeth; that the organs of support are often indiscriminately selected, and are neither adapted in form,

situation, or structure for such uses; and that they are frequently diseased and insecurely attached to the jaw, or are mutilated for the reception of clasps, we can readily understand to what unlimited extent this method is subject to abuses. In fact, few other special processes in mechanical practice have been so fruitful of evil as that under consideration, and the opprobrium which but too justly attaches to it in professional as well as popular estimation, is chargeable more properly to bad faith and *unskilfulness on the part of the operator, and to want of necessary attention to the cleanliness of the substitute and the organs of the mouth on the part of the patient,* than to any inherent unsuitableness of the method itself. Nevertheless, it must be admitted that, under the most favorable circumstances, the teeth clasped are not wholly exempt from liability to injury, and this circumstance in itself renders it the more imperative that the process should be surrounded by all the safeguards that skill and ingenuity can devise.

The opinion, at one time current, that the injury inflicted upon the teeth by clasps was mainly the result of mechanical action, has given place to the more defensible view that the causes concerned in its production are chiefly of chemical origin. Thus, the secretions of the mouth, with particles of food being retained between the clasp and the tooth for a sufficient period of time, and exposed to the favoring conditions of warmth and immobility, suffer a process of putrefactive decomposition by which acids are eliminated, and which, in their nascent state, act with perceptible energy upon the bone constituents of the tooth, producing disintegration and ultimate decay. The rapidity and extent of this action will depend much upon the nature and quantity of the acids present; the structural characteristics and vital resistance of the teeth; the mechanical execution, adaptation, and composition of the plate; and the personal habits of the patient with respect to cleanliness.

The most usual seat of structural disorganization in these cases is at the neck of the tooth, where the enamel is thinnest, and is sometimes limited to a circumscribed spot, but oftener extends on a line with the gum, involving nearly or quite all of that part of the neck of the tooth embraced by the clasp. At first the enamel becomes bleached and softened as though macerated, and is ordinarily very sensitive to both chemical and mechanical irri-

tants. With a continuance of the cause, the superficial portions of the affected parts become more and more thoroughly disintegrated, and sooner or later assume the open form and characteristics of ordinary decay. If, as was formerly supposed, decay or solution of tooth-bone in these cases resulted from mechanical attrition, or wearing away of the enamel, the injury would be inflicted at points distant from the neck of the tooth where the clasp lies in more direct and immediate contact with the protuberant portions of the crown; but we find that decay, from this cause, is not only of infrequent occurrence at such points, but, on the contrary, the enamel here is frequently found condensed and polished by the mechanical action of the clasp. Certain conditions of the plate and clasp undoubtedly favor mechanical action and accelerate the destruction of the tooth; as where the clasp bears unequally with sharp and unfinished edges upon the tooth, or where the base is faulty in its adaptation to the mouth, admitting, by its mobility, of irregular traction or pressure upon the organs of support. Whenever the artificial appliance is thus unskilfully constructed and applied, and free interspaces are furnished for the lodgment and retention of particles of food, and the teeth clasped are defective in structure, and we have conjoined with these, an utter disregard of cleanliness in regard to the substitute and remaining natural teeth, the destruction of the latter is certain, rapid, and generally irretrievable.

The Teeth to which it is most Proper to Attach Clasps.—The utility, comfort, and appearance of a partial set of artificial teeth in the mouth will depend much upon the fitness of the natural organs selected for the purpose of support. "A clasp," says Professor Harris, "should never be applied to a loose tooth, or to one situated in a diseased socket, or which is so much affected by caries as to render its perfect restoration and permanent preservation impracticable, and when none but such can be had, the proper course to pursue is to extract every tooth in the jaw, and replace the loss of the whole with an entire denture. The application of clasps to diseased or loose teeth, always aggravates the morbid condition of the parts, and causes the substitute which they sustain to become a source of annoyance to the patient. Besides, such teeth can be retained in the mouth only for a short time, and when they give way, the artificial appliance becomes

useless, and even while it is worn, it is not held firmly in place, but is moved up and down by the action of the lips and tongue, so that its presence can hardly escape observation from the most casual observer."*

Teeth, also, that are too short to admit of sufficient breadth to the clasp to impart stability to the substitute, and those that stand very irregularly in the arch, rendering it difficult for the patient to apply and remove the appliance, are unsuitable as organs of support.

In reference to the individual classes of teeth, it may be observed that the incisors, both as regards form and situation, are inadmissible for clasping, and are, therefore, never used for this purpose. The cuspid teeth, likewise, being placed conspicuously in the front part of the mouth, cannot be securely embraced without manifest exposure of the clasp; besides, the conical form of these teeth makes the use of a very slender clasp indispensable; hence, these teeth are rarely employed, and may only be used when, in the judgment of the operator, the necessities of the patient for the time being seem to require it.

Either the anterior or the second molars, when sound and firm, offer, in respect of their general conformation and position in the arch, the most desirable and efficient support for parts of sets of teeth. The crowns of these teeth generally afford ample breadth to the clasp; have nearly parallel walls; and furnish, by the strength and immobility of their attachments to the jaw, the greatest security to the artificial appliance. The anterior molars are preferable where these are remaining in good condition, or are susceptible of being properly restored and preserved if diseased or carious.

Of the bicuspids, the posterior are to be selected, if practicable, as these better favor the concealment of the clasps; to effect which more perfectly, in the use of either the first or second bicuspids, it will be sufficient in many cases to embrace only the posterior half of the crown.

The third molars, or wisdom teeth, will seldom admit of the application of clasps, as the crowns of these teeth are usually very short and cone-shaped, the walls converging abruptly from the gum; besides, the retractive forces applied to the anterior teeth of

* "Principles and Practice of Dental Surgery," page 717.

the substitute would, on account of the increased leverage consequent upon the extension of the plate back to these teeth, tend either to disengage the clasps or produce displacement of the teeth to which they are applied.

In supplying the loss of the inferior incisors, the appliance should, as a general thing, be attached either to the anterior or posterior bicuspids, as these teeth stand more nearly vertical in the arch. In fixing partial lower dentures, it will be sufficient to simply provide against mobility of the base, as they are favored rather than opposed, as above, by gravitation.

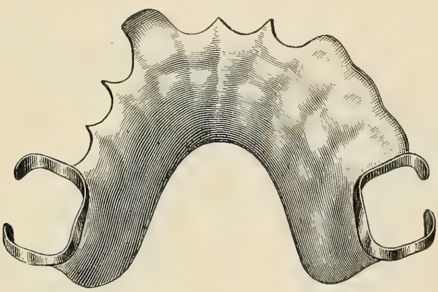
The replacement of the inferior teeth posterior to one or both bicuspids, however, is more frequently demanded; in which case it is customary to attach the clasps to the teeth immediately in front of and adjoining the vacuities on each side. It will not, however, be necessary to attach clasps in these cases whenever the edentulous portions of the jaw present a distinctly scooped form or marked concavity of outline, forming a kind of bed for the plate. If, on the other hand, the ridge falls back with a tolerably uniform inclination from the teeth in front, with no sufficient elevation at the base of the coronoid process, it may become necessary to provide against backward displacement of the substitute by attaching clasps, as before stated, to the teeth immediately in front. In any case, if the third molars remain, partial or stay clasps may be attached to each heel of the plate, and so adjusted as to rest against the anterior face of these teeth, obviating entirely the necessity of clasps in front.

Separation of the Teeth for the Reception of Clasps.—The practice of separating the teeth with the file to provide for the application of clasps should always be avoided, since the liability of the teeth, thus denuded of enamel, to decay is greatly increased under circumstances so favorable to their disintegration. In the case of young subjects, especially, where the teeth are but imperfectly consolidated, and in adults whose teeth are defectively organized, presenting but a feeble resistance to the disintegrating agents usually present in the mouth, the use of the file, for the purpose indicated, is pernicious, and should never be resorted to. When it is found necessary to separate or straighten up the sides of the teeth for the reception of clasps, a thin diamond disc should be employed, as it is less annoying to the patient, does the work

in less time, and is not so destructive to the tooth structure as the file.

Whenever a plain necessity for this operation exists, a careful examination of all the teeth to which it is proper to apply clasps should be made, and if decay is found upon their proximate surfaces, the separation should be made between the teeth so affected; and this circumstance should, in most cases, determine the selection, though the affected tooth or the one adjoining may not be esteemed, in other respects, the best for the purposes of support. If decay exists on the proximate surface of only one of the teeth to be separated, a safe-sided diamond disc, revolved by the dental engine, should be employed, and the cutting confined entirely to the carious tooth, leaving the enamel of the one adjoining unbroken. The cavity of decay should be well filled, and the filed surface thoroughly condensed and polished.

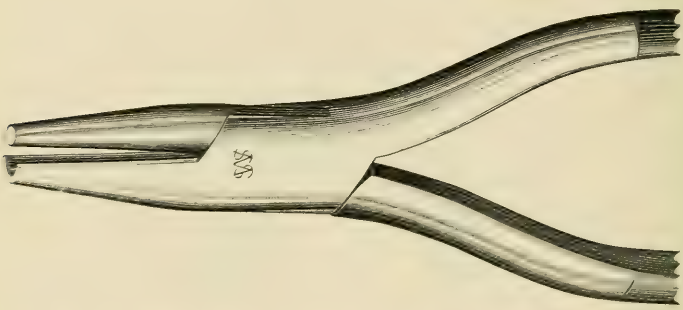
Fig. 77.



Modifications in the Form of Clasps.—1. *Plain Band.* The most usual form of clasp is that shown in Fig. 77. It consists of a plain metallic band of greater or less width and thickness, and is made to embrace the larger portion of the circumference of the tooth. In regard to the general properties of metallic clasps, it may be said that they should be, as nearly as practicable, of the same quality or fineness as the plate or base to which they are united; they should be heavy enough to impart adequate security to the attachment—usual thickness, 22 of the gage plate—and sufficiently elastic to embrace accurately the more contracted parts of the teeth after having been temporarily forced apart in passing over the enlarged portions of the crowns. In constructing a plain band or clasp, a strip of sheet-lead or other

pliable substance may first be fitted accurately to the plaster tooth, making it of the required width, and shaping the edge next the gum in conformity with the irregularities in the latter around the neck of the tooth; the exact counterpart of the pattern thus obtained is then cut from the plate to be used in the formation of the clasp. The strip thus obtained is then bent with round-nosed or grooved pliers (Fig. 78), until conformed as perfectly as possible to every portion of the surface of the tooth embraced by it. This coaptation should be sufficiently accurate to exclude perfectly all solid substances from between the clasp and the tooth. A more accurate adaptation of the clasp may be secured in the following manner: First secure a pattern, as before described, and by this cut from a thin strip of platinum, say No.

FIG. 78.

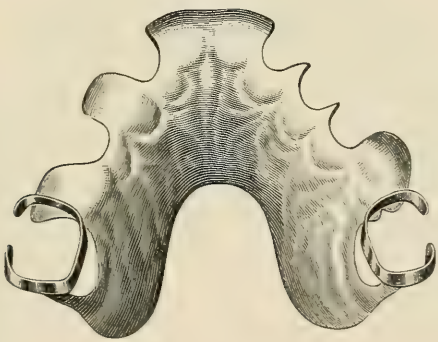


30 or 32 of the gage plate, a band of the required size and form, and press or burnish it accurately to the form of the plaster tooth. The soft and pliant condition of this metal will admit of its being easily adapted to any irregularities upon the lateral walls of the tooth. The band thus molded to the tooth is then carefully removed from the model, and its central portion filled with a mixture of plaster and sand, with a small metallic wire or bar passing through the center to support it while soldering. The outer or exposed surface is then coated with a mixture of borax, and small scraps or fragments of gold plate of equal fineness with the main plate are placed at intervals and fused with the blowpipe until diffused uniformly over the surface. Small pieces may be added from time to time, until the required thickness of the clasp is obtained. The piece should be heated uniformly throughout to induce an even flow of the gold over the exterior surface of the

platinum ring. By this method a faultless adaptation of the clasp to the tooth may be secured, provided the form of the latter is correctly represented on the model. In all cases where the plain band is used, it should be made as broad as the tooth will admit of, as a clasp so formed gives greater stability to the plate, and does not endanger the tooth clasped in as great a degree as a narrow one.

2. **Standard Clasp.**—To guard more perfectly against the retention of vitiated secretions and particles of food around the neck of the tooth, a method of constructing clasps has been devised and introduced to the notice of the profession by Dr. C. W. Spalding, which, by leaving the cervical portion of the tooth in a great degree uncovered, permits, as he claims, the action of the tongue

FIG. 79.



and the natural circulation of the fluids of the mouth, to wash or cleanse that portion of the tooth most liable to be injuriously affected. In commenting on this method, Dr. Spalding remarks: "I have for many years been in the habit of employing *narrow* clasps for the purposes of support, making them of sufficient thickness to give the required strength, and attaching them to the plate by means of standards, so arranged as to induce the removal of accumulations between the clasp and tooth, by the circulation of the saliva (Fig. 79). The use of one or more standards as a means of attachment also provides, by a variation of their length, for the grasping of the tooth at any desired point. If the tooth is long, and particularly if it is at the same time bell-crowned, the point selected should be toward the grinding sur-

face, as far from the gum as is found practicable. If the tooth is short and of such form that it can be successfully clasped at no other point than that near the gum, the plate should be cut away at least 1 or 1½ lines from the tooth, and standards introduced for the purpose of promoting circulation, by affording a free passage for the ingress and egress of fluids. These standards should also be *narrow*, no wider than the clasp itself, and should constitute the only point of union between the clasp and plate. Half-round wire will be found to be a very convenient article for making clasps. The particular *form* of the clasp is, however, immaterial if it is both narrow and strong."

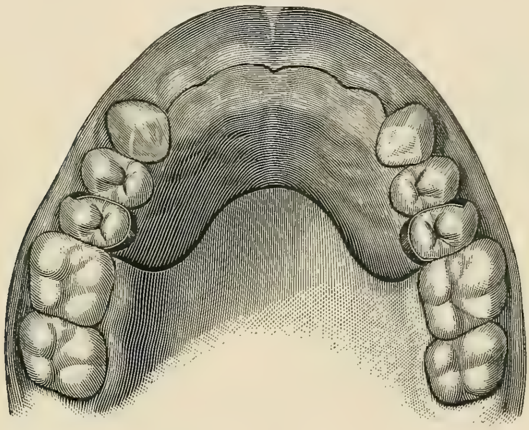
3. **Scalloped Clasp.**—Somewhat analogous in form to the clasp just described, and constructed with a similar design, is the one recommended by Dr. B. T. Whitney. A plain band of gold is fitted to the tooth in the manner first described, when that portion of it next the gum on the lingual side of the tooth is scalloped or cut away in the form of a semicircle or arch, the ends of the clasp being in like manner narrowed sufficiently to relieve them from contact with the neck of the tooth. The intermediate points of the clasp which serve to unite the latter to the base may be two or more in number, and should be wide enough to impart adequate strength to the attachment. A clasp so formed and applied to the base will present very nearly the appearance of the standard clasp as represented in Fig. 79. Dr. W. recommends soldering but a single point at first, and then having tried the plate in the mouth and adjusted the clasp properly to the tooth, remove and solder the remaining point or points.

4. **Partial or Stay Clasp.**—This form of clasp, instead of embracing the tooth, is designed to steady or fix the substitute in place, by simply resting against one side of the tooth to which it is applied. They should be so connected to the plate that, when pressed over the enlarged portions of the crowns of the teeth, they will spring readily into place and adapt themselves closely to the more contracted parts near the gum. In cases where there is no adequate opposing force to that exerted by the clasp, care should be taken that no more pressure is produced than is necessary to keep the substitute in place, as, without this precaution, outward displacement of the teeth is liable to occur, and the appliance, losing its bearing upon the teeth, soon becomes loosened and in-

secure in the mouth. The result alluded to should be particularly guarded against in the case of young subjects, whose teeth are easily moved by the application of very slight forces.

Modifications in the Form of Plates for Partial Dentures Supported in the Mouth by Clasps.—The particular form and dimensions of a plate, when clasps are used, will be mainly determined by the number and position of the teeth to be replaced, and by the location of the natural organs to which the clasps are attached. It will be sufficient in this place to indicate the leading forms as they relate to the substitution of the several classes of teeth. In

FIG. 80.



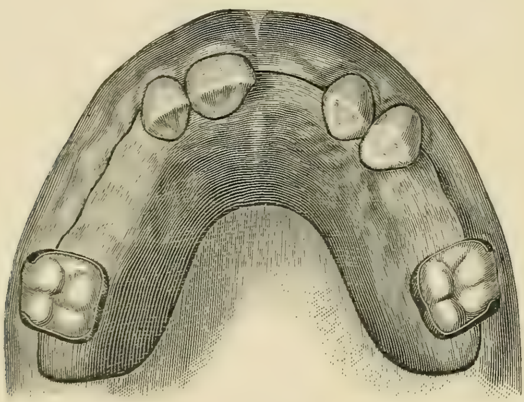
supplying the loss of a superior central or lateral incisor, it will be sufficient in many cases to attach the plate to either a bicuspid or molar on the same side. If two or more of the front teeth, however, are to be replaced, it is better to extend the plate on each side of the palatal arch, and attach to a bicuspid or molar (Fig. 80). In all cases where it is necessary to extend a narrow plate from the extreme front part of the mouth to a single tooth situated posteriorly in the arch, the former should be strengthened by soldering a narrow rim of plate or half-round wire along the border next the teeth, and the clasp should, whenever practicable, pass in front of and embrace the anterior face of the tooth to which it is applied.

If an anterior bicuspid is to be replaced, the plate may be attached to the adjoining bicuspid, or if both are absent, then to

the first molar, or the clasp may embrace both of the latter if remaining and no separation between them exists.

Take a case where it is necessary to supply the loss of the two bicuspids on one side, and the first bicuspid and first molar on the opposite, the plate being attached to an anterior molar and second bicuspid. The antero-posterior extension of the plate, in connection with the bicuspid tooth, greatly favors the stability of the substitute, and, provided the plate and clasp are accurately fitted to the parts, the support afforded by a bicuspid tooth under such circumstances is equivalent to that furnished by a clasp about a

FIG. 81.



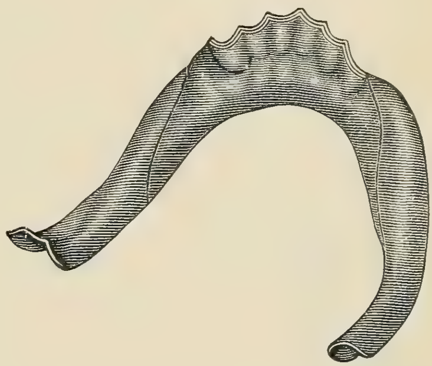
firm and well-formed molar. A base so supported may be made to sustain a number of teeth with much security.

Either the anterior or posterior molars, if firm and securely attached in the jaw, will afford adequate support to a plate replacing all of the teeth anterior to them. Even a single molar situated on either side of the arch, if similarly circumstanced, may be made to sustain, with tolerable firmness, a base supplying the loss of all the remaining teeth, though, ordinarily, *it is better to extract such teeth* and substitute an entire upper denture. In all cases where any considerable number of teeth anterior to those clasped are to be replaced, and a vacuity on the ridge exists posterior to the latter, the plate should be extended back and overlap the ridge (Fig. 81), the latter affording a counterpoint of resistance when traction is made upon the anterior teeth, thus directing the forces

applied more on a line with the long axes of the teeth that sustain the appliance.

In supplying the loss of the inferior molars and bicuspids, or any number of these teeth, the form of plate represented in Fig. 82 is generally employed. The parts of the plate overlapping and resting upon the ridge behind are connected with each other by a narrow strip of plate extending round the ridge, hugging the lingual side of the anterior teeth. This latter portion of the plate should be accurately swaged to the form of the gum on which it rests, and should be made narrow enough to avoid encroaching upon the reflected portion of mucous membrane, the glands beneath the tongue, or the frenum linguæ.

Fig. 82.



Reinforcing. — To avoid wounding these parts, and to allow them unobstructed play, it will be necessary to make this portion of the plate quite narrow; and as a single thickness of plate would not impart adequate strength, *it is better practice to reinforce or double this connecting band*—the duplicate band extending back to the lateral wings of the plate, and crossing them obliquely, as indicated by the lines in Fig. 82. Additional strength will be given by doubling the entire plate, but this is not generally required. The outer border of those portions of the plate overlapping the ridge may be turned up to the depth of from ½ of a line to a line, to form a groove or socket for the reception of the ends of gum teeth, or blocks, if such are used; while the inner margins should terminate in a rounded edge, extending from heel to heel of the plate, this form being given to it either by turning the edge over and filling in the groove with solder, or by soldering a narrow strip of plate or half-round gold wire along the border. The circumstances or conditions which make the use of clasps necessary in these cases, as well as those, also, which contraindicate their employment, have already been noticed. The practice of extend-

ing a narrow band or wire from the sides of the plate round the outer border of the ridge in front of the anterior teeth, to prevent a backward displacement of the base, is liable to produce irritation and tenderness of the mucous membrane immediately over the roots of the anterior teeth, and should, therefore, never be resorted to unless there are no teeth remaining to which clasps may be applied.

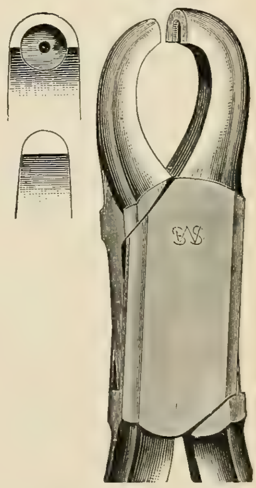
If the appliance is designed to restore the loss of teeth recently extracted, and where but little or no change has occurred from absorption of the parts, the portions of the plate which pass in between the adjoining teeth should terminate a line or more within the outer circle of the remaining teeth; and where the space, if it happens in the front part of the mouth, admits of two or more teeth, the edges of the extended portion of plate should be scalloped in correspondence with the festoons of the gum, as seen in Fig. 80. In such cases, plain or plate teeth, by which is meant those which represent only the crowns of the natural organs, should be employed; these, resting on the edge of the plate, will overlap somewhat, with their anterior edges resting directly upon the gum in front, taking the place occupied by the crowns of the extracted teeth. On the other hand, if sufficient time has elapsed after the extraction of the teeth to permit the changes in the form of the ridge to occur incident to partial or complete absorption of the parts, and a greater or less concavity exists between and above the teeth on the outside of the jaw, the plate, where it passes into the interspace, should extend some distance over the border of the ridge.

Swaging the Plate.—Having determined upon the proper form and dimensions of the plate for any given case, its outlines may first be traced upon the model; from this an exact pattern in lead may be obtained, or the pattern may be sufficiently ample to partially overlap the cut extremities of the teeth when the latter are not represented upon the die, having been previously cut from the model, as shown in Fig. 57, page 150. The outlines of the pattern are then traced upon the plate of gold, or other metal used for the base. The redundant portions of plate are then cut away with plate-shears and forceps, and the edges trimmed smooth with a file. A very convenient and almost indispensable instrument for cutting away the plate in conformity with the

palatal curvatures of the teeth, is the plate-forceps as exhibited in Fig. 83.

The plate cut to the proper form is now placed upon the die and brought as nearly as possible into adaptation with a wooden or horn mallet; it is then placed between the die and counter, the latter resting on an anvil or other equally resisting surface, when the two metallic pieces are brought forcibly together with a few steady and well-directed blows of a heavy hammer. Tilting of the die, resulting sometimes unavoidably from a one-sided blow, may be obviated by placing a cone-shaped piece of cast-iron, brass, or zinc over the die, the base of the cone resting on the back of the die; by this expedient the force of the blow is equalized and concentrated more directly over the die. The metallic swages should at first be brought cautiously together, and should be separated after the first blow or two, to enable the manipulator to detect and remedy any malposition of the plate before it becomes intractable from continued swaging. If, in the process of stamping, any portion of the plate is found cracking or parting, its further extension at that point may be prevented by flowing a little solder at the termination of the fissure.

Fig. 83.



Annealing the Plate.—During the progress of swaging the plate should be frequently annealed, which is done by bringing it to a full red heat under the blowpipe or by placing it in the furnace; the plate is thus rendered more pliant, and can be more readily and perfectly forced into adaptation to the irregularities on the face of the die.

If, after somewhat protracted swaging, the plate is not conformed perfectly to the face of the die, another and unused counter should be substituted for that in use; and, indeed, it is better in all cases to have duplicate copies both of the die and counter in reserve with which to complete the swaging, inasmuch as more or less deformity of both swages unavoidably occurs before the plate is brought into very accurate coaptation with the die. The

stamping conducted thus far, the plate may be applied to the plaster model, and if found too full at any point, it should be trimmed with a file to the exact dimensions required. The margins of the plate adjoining the necks of the teeth should be permitted either to lie closely to them, or should be cut away, leaving a space equal to a line or more between the plate and the teeth; for if but a very narrow line of uncovered gum remains at these points, injury to the parts immediately surrounding the necks of the teeth is more liable to occur from strangulation of the interposed gum, than if the plate were further removed from the teeth or rested directly against them.

Adjusting and Strengthening the Projections or Tongues of the Plate.—If the portion of the plate which passes in between the remaining teeth is quite narrow, as where but a single tooth is to be supplied, it should be strengthened by wiring the edges or doubling the plate at such a point. It is also advisable in many cases, in order to provide more perfectly against fracture or distortion of the base in mastication, to wire or double the entire border of the plate adjoining the necks of the teeth. Narrow bands of gold resting against the necks of the teeth, constructed and adjusted after the manner of stay clasps, are sometimes soldered to the edge of the plate next the teeth; but unless the substitute is frequently cleansed, as well, also, as the teeth to which the clasps are applied, serious injury is likely to be inflicted upon the teeth implicated.

The edges of those parts of the plate occupying the vacuities on the ridge should be filed thin to admit of a more accurate adaptation of the artificial with the natural gum, and should not, as before observed, ordinarily extend beyond the outer circle of the contiguous teeth, allowing the gum extremity of the artificial tooth to overlap and rest directly on the natural gum above. If, however, the concavity between and above the teeth on the external border of the ridge is considerable, the interdentinal portions of the plate should overlap the border completely and underlie the porcelain gum.

Adjusting Clasps to the Plate.—Having proceeded thus far in the operation, the plate and clasps should next be united to each other, and *the utility and comfort of the appliance in the mouth, as well as the safety of the natural organs used for the purpose of sup-*

port, will depend in a great measure upon the accurateness of the relation of the several parts of the appliance to the organs of the mouth; it being a matter of primary importance that the various parts of the substitute should be so adjusted to the remaining teeth—especially those to which the clasps are applied—and the ridge and palate, that it shall not, in any material degree, act as a retractor upon the organs of support, or furnish interspaces for the lodgment of food, while at the same time it should be so fitted as easily to be removed and readjusted by the patient.

Manner of Securing Clasps to the Plate.—The clasps having been fitted to the plaster teeth and the base swaged to the form of the palatal arch and ridge, the plate is placed in its proper position in the mouth and an impression in wax taken of the latter with the plate in place. The impression, with the plate adhering, is then removed from the mouth, its surface oiled, and a model obtained in the manner heretofore described. If, in separating the model and impression, the plate adheres to the latter, it should be detached and adjusted to the model and the clasps arranged upon the plaster teeth. The plate and clasps may now be attached to each other temporarily, with adhesive wax, in the relation they occupy on the model, and then removed carefully and the clasps and palatal face of the plate imbedded in a mixture of nearly equal parts of plaster, sand, and asbestos. Before uniting the two pieces on the model with wax, however, the ends of the clasps should be slightly spread apart, in order that they may part readily from the plaster teeth, without, in any degree, changing their exact relation to the plate; in doing this, it should be observed that all parts of the clasps which are to be united to the plate should remain in close contact with the plaster teeth. After the plaster mixture, in which the plate and clasps are imbedded, has become sufficiently hard, the portions of wax which temporarily united the latter should be removed, and the surfaces of the clasps and plate, where they unite with each other, coated with borax ground in water to the consistency of cream; small pieces of solder are then placed along the lines of contact, the investment heated in the furnace until the plate acquires a dull red heat, when it is removed, placed upon a suitable holder, and the solder fused with the blowpipe.

Whenever the form and inclination of the teeth to be clasped

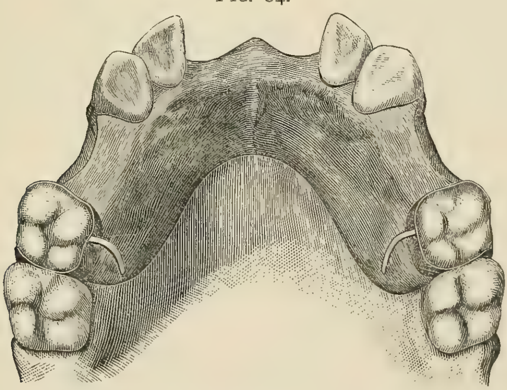
are not fairly represented on the model, owing to dragging or displacement of the wax in withdrawing the impression, the difficulties of securing a proper relative adjustment of the several parts of the appliance will be increased; but either of the following methods, if carefully and accurately manipulated, will secure accurate results:

1. Plaster-of-Paris or modeling compound may be substituted for wax when taking an impression with the plate in the mouth. With the proper use of these materials, the exact form and inclination of the teeth will be better preserved; and when employed they should be filled in with plaster for the model immediately after removing them from the mouth. The subsequent steps in the operation are precisely similar to those described when wax is used.

2. Another method is to adjust the clasps and plate to the parts in the mouth, attach them temporarily in their proper relation, and remove, invest, and solder in the usual way. This may be accomplished in the following manner: First, spread apart the ends of the clasp somewhat to permit it easily to be removed from the tooth; place this upon the tooth in the mouth to be clasped; then adjust the plate, and attach the two to each other by pressing a piece of stiff, adhesive wax in against the clasp and plate where they unite; harden the wax by placing against it, for a few minutes, a pledget of cotton, or the end of a napkin, moist with cold water; then remove the plate and clasp carefully from the mouth, and invest and solder as before. The plate, with one clasp permanently attached, is now placed back in the mouth, and the second clasp adjusted to the tooth on the opposite side in the manner before alluded to; this is then temporarily fastened to the plate and otherwise treated in like manner as the one first described. If the teeth to be clasped are favorably formed and regularly arranged in the arch, both clasps may, at the same time, be temporarily attached to the plate in the first instance; if not, it will be impracticable to remove them from the teeth without disturbing the wax and changing their relation to the base and the teeth clasped. The additional labor and consumption of time incident to a separate attachment of the clasps will, in proportion as they secure better results, amply reward the operator for his painstaking.

Plaster is sometimes substituted for wax in this process; in which case it is introduced into the mouth on a small piece of wax or sheet-lead and pressed gently against the uniting portions of the plate and clasp, and allowed to remain until sufficiently hard. Any superfluous portions around the tooth that may hinder the easy removal of the clasp should now be cut away, when the pieces so attached to each other are removed from the mouth. A separation of the plaster from the clasp or plate, or both, may occur when removing the latter; in this case the several parts may be readily and accurately adjusted to each other again in their exact relation when out of the mouth, as the latter will be plainly indicated by the impression made by the plate and clasp in the plaster. Being readjusted, they may be further secured by sticking them together with a little softened wax, when they are invested, the temporary fastening of plaster removed, and the pieces united by soldering. The use of plaster in these cases unquestionably possesses many advantages over wax for the purpose, as the latter is liable, unless most skilfully manipulated, to become

FIG. 84.



displaced in removing it from the mouth; and this change, when it occurs, not being indicated by inspection of the wax, is incapable of timely correction.

3. Still another method is that contrived by Dr. Fogle and described by Dr. Cushman in the tenth volume of the *American Journal of Dental Science*. It consists in securing the proper relation of the clasps to the teeth in the mouth by the use, in the first instance, of what are termed "temporary fastenings." The plate

and clasps are first applied to the model, and are then connected by a narrow strip of plate or piece of wire bent in the form of a bow, the concavity facing the model, one end of which is soldered to the palatal side of the clasp, and the other to a contiguous point upon the plate, as exhibited in Fig. 84, and the pieces thus temporarily united are removed from the model and adjusted to the parts in the mouth. If the position of the clasps is found in any respect faulty, they can be easily and accurately adapted to the walls of the teeth by bending or twisting the connecting strip in any desired direction with pliers or other instruments suitable for the purpose. This accomplished, the plate and clasps are removed, and the operation of permanently uniting the clasps to the plate performed in the usual manner.

In the use of partial dentures, there is always increased liability to injury of the soft parts by reason of pressure being concentrated upon limited or circumscribed portions of the alveolar ridge embraced in interdental spaces, thereby diminishing resistance to the pressure of the plate at such points. As a consequence, the latter is forced into the soft tissues, producing more or less irritation and inflammation, and consequent tenderness and pain on pressure, and, generally, either partial denudation of the necks of the natural teeth abutting upon the interdental spaces, or strangulation, congestion, and hypertrophy of the gum in immediate contact with them.

Clasps with Spurs.—A simple device, by which the results alluded to may be obviated, consists in attaching to the clasps, above or below, a strip or spur of gold at suitable points, long enough to overlap or rest upon the masticating surface of the tooth clasped, forming a hook or partial crown-cap. These will afford fixed points of resistance to pressure and effectually prevent the plate impinging upon the underlying tissues. The same expedient may be adopted also in the case of partial dentures retained by adhesion or atmospheric pressure, by attaching similar gold spurs or caps to the border of the plate at suitable points contiguous to the bicuspids and molars.

Charles Rathbun, of London, England, relates, in the *Dental Cosmos* of December, 1886, a method of constructing partial pieces which embodies the same principle of crown-support as described above, the essential details of which are here given:

In Fig. 85 we have the first bicuspid standing; the second bicuspid and cuspid in that case filling the rôle of the lateral, missing from its position. The bicuspid is pear-shaped, its largest diameter being just below the grinding surface, and the molar is a trifle undercut. A No. 7 or 8 English gage gold plate, struck from a model made from a modeling compound impression, would not touch the necks of either the bicuspid or molar, owing to the fact that these teeth would "draw" a little in the impression, and it should be fitted over the shoulder at the neck on the lingual side of the cuspid, left clear of it at the distal side, and have a stay or clip resting just above the prominence on that side of the tooth. A band should be soldered to the plate at the lingual side of the bicuspid, to grasp that tooth at its largest point, viz., about one-third of the distance from the grinding surface to the neck; also, a band fitted to the molar to reach from about the middle of the lingual side far enough around the mesial face to clasp over the prominence at the mesio-buccal aspect of the tooth; this band to

Fig. 85.

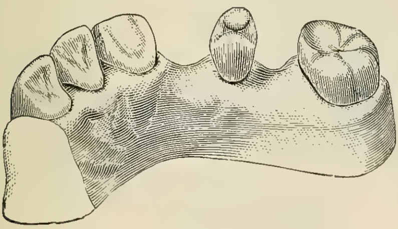
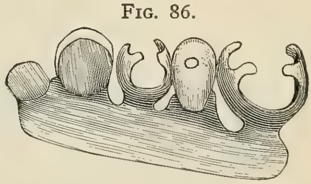


Fig. 86.



be fitted to grasp the tooth at its fullest part, as in the case of the bicuspid. (See Fig. 86.) Wires or clasps at the necks of teeth of this class do no end of damage to the teeth, and are open to the great objection that a case may go in very hard, and yet when the clasps are past the large part of the teeth the case is quite loose and shaky. The bands I have described do not bear on the teeth at all until the case is within about a line of its place, and then each one bears on its own tooth irrespective of the others, and, be it borne in mind, touches the tooth at a point where the chance of decay is simply infinitesimal. If a porcelain cuspid and bicuspid be ground in properly, the clasps will not be visible externally, which cannot be said of the broad gold band carried across the buccal face of the natural tooth.

CHAPTER XVII.

PARTIAL DENTURES SUPPORTED BY ATMOSPHERIC PRESSURE OR ADHESION.

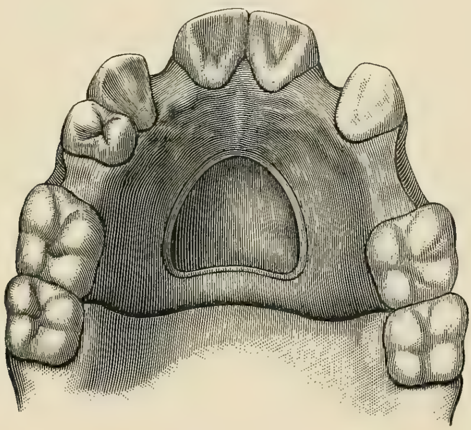
The method of attaching partial sets of teeth to the superior jaw by means of atmospheric pressure, or by adhesion, is much more generally practised than formerly, and whenever the condition of the soft parts of the mouth, the general configuration of the palatal arch, and the antagonism or occlusion of the artificial with the natural teeth favor its adoption, there are good and sufficient reasons why either of these forces should, in all practicable cases, be utilized in preference to the use of clasps for purposes of attachment.

Modifications in the Form of the Base.—If vacuities exist at various points on the ridge, the plate on which the teeth of replacement are mounted should be ample in its dimensions, covering nearly or quite all of the hard palate. The general form of the base, where several teeth scattered throughout the arch are required, is shown in Fig. 87. In most cases, whether but one or a greater number of teeth are to be replaced, increased adherence and stability of the substitute will be better secured by permitting the plate to cover the larger portion of the roof of the mouth; though, in cases that present the best form of the vault, a diminished surface may be given to the base with equally satisfactory results. In the substitution of a single incisor, for example, it will frequently be sufficient to employ a very small plate, covering only a part of the anterior sloping wall of the palate. In the latter case the plate used may be very thin, say No. 30 standard gage; it will thus impede the movements of the tongue less, and may be swaged more accurately to the parts. If constructed with an air-chamber, the latter should be quite shallow.

A somewhat anomalous form of atmospheric-pressure plate, employed in the substitution of one or two bicuspid teeth on each side, is described by Professor Taft, the design of which is to secure in such cases increased stability of the substitute, while

much of the palatal arch is left uncovered. It consists of two lateral cavity plates accurately adjusted to the sloping walls of the palate on each side, immediately adjoining and partly occupying the spaces to be supplied. These lateral plates may be made as large as a dime, or somewhat larger, and of an elliptical shape if both bicuspids on the same side are to be replaced, and are connected with each other by a narrow band of gold plate, two lines or more in width, having an anterior curvature, and resting on the front wall of the palate, two or three lines behind the anterior teeth. The entire appliance may be constructed from a single piece of gold plate swaged accurately to the parts; or the lateral plates and connecting band may be separately swaged and secured

FIG. 87.



in their proper relation to each other in the mouth with wax or plaster, when they are carefully removed, invested, and soldered together; it should then be reswaged to correct any change of relation that may have happened during the concluding manipulations. The liability of the plate to ride upon the central and raised portion of the palate, when pressure is made upon one side, throwing the plate off from the ridge on the other, as in the case of a base extending across the arch, is in a great degree obviated by the method just described.

Manner of Forming an Air-chamber.—Atmospheric-pressure plates for partial cases are constructed with a central air-chamber; in which case, the part of the model representing the chamber

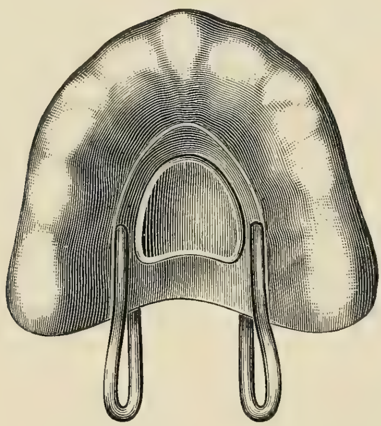
may be formed in either of the ways mentioned in the chapter on Plaster Models. The model prepared, the form of the plate to be used is first indicated thereon, and from this a pattern in sheet-lead is obtained, which is placed on the plate of gold or other metal, and its outlines traced with a pointed instrument; the redundant portions are then cut away with plate shears and forceps. The plate is now placed on the die and brought as nearly as possible into adaptation to the latter with the No. 1 counter-die (see Progressive Counter-dies) ; it is then interposed between the die and the larger counter, and swaged until it conforms perfectly to the face of the former, annealing the plate frequently to render it more pliant and manageable under the hammer.

The Use of a Tracer in the Swaging Process.—Unless the plate used is purer and thinner than is generally employed, or than is consistent with the required strength, it will fail to be forced perfectly into the groove around the chamber by the process of swaging alone; a more definite border, however, may be formed by forcing the plate in at this place with a small, smooth-faced stamp or tracer, shaped to the angle of the groove, passing round the chamber and carefully forcing the plate in with the stamp and a small hammer or mallet until a somewhat sharp and abrupt angle is obtained to the palatal edge of the chamber. After the chamber is as perfectly formed as possible in this way, the plate should be well annealed and again swaged to correct any partial deformity occasioned by stamping the chamber.

The Soldered Air-chamber.—A still more perfectly defined angle may be given to the borders of the chamber in the following manner: After swaging the plate sufficiently to indicate the exact position and form of the chamber, the portion forming the latter should be separated from the main plate by completely dividing it with a saw, or small, sharp, chisel-shaped instrument, cutting on a line with the groove around the chamber until the latter is entirely separated. The cut portion of the main plate is then trimmed evenly with a file, being careful not to enlarge the opening more than is required to remove the irregularities of the edge formed in cutting. The plate, with its central portion removed, is then placed upon the die, when a separate piece of gold cut to the general form of a chamber, but somewhat larger than the opening in the main plate, is adjusted over the chamber, and struck up with the plate

until the overlapping portions of the central piece are forced down upon the plate around the margins of the chamber. It is not, however, always necessary to employ a separate piece of gold for the chamber, as the central portion cut from the plate in the first instance may be sufficiently enlarged for the purpose. This is accomplished by first flattening out the detached portion, annealing it, and then passing successive portions of its edges $\frac{1}{16}$ of an inch or more between the rollers, the latter being sufficiently approximated to produce a perceptible thinning of the margins. When the entire border of the chamber piece has been thus attenuated and extended, it will be found so much enlarged that, when adjusted to the die and swaged in connection with the main plate,

Fig. 88.



its borders will overlap and rest upon the margins of the opening in the base, as in the other case.

The portions of the plate and cut chamber lying in contact and temporarily secured in position by means of wire clamps, as shown in Fig. 88, are now coated with borax and pieces of solder placed along the line of union on the lingual side of the plate, when the two pieces, being transferred to a bed of charcoal, are permanently united by flowing the solder with a blowpipe. Sufficient heat should be applied to induce an extension of the solder between the two portions of plate, filling up completely the gap between them to the edge of the orifice in the main plate, forming, at this point, a square and well-defined angle to the margins of the chamber.

CHAPTER XVIII.

METHOD OF OBTAINING AN ANTAGONIZING MODEL FOR PARTIAL DENTURES; SELECTING, ARRANGING, AND ANTAGONIZING THE TEETH; INVESTING, ADJUSTING STAYS, SOLDERING, ETC.

Having constructed the plate or base to be used as a support for partial sets of teeth in either of the ways described in the preceding chapter, it will be necessary, before arranging the teeth on the plate, to secure an accurate representation of all the remaining natural teeth of both jaws in plaster, preserving accurately the relation which these organs bear to each other in the mouth. This is effected by what is called an *antagonizing model*, and may be secured in the following manner:

Taking the "Bite."—A roll or strip of adhesive wax is first attached to the lingual border of the plate, and its adhesion secured by holding the opposite side of the plate for a moment over the flame of a Bunsen burner or spirit-lamp. The wax used for articulating purposes should be harder and more tenacious than plain beeswax, and may be compounded from the following formula:

Beeswax,	1 pound.
Gum mastic,	2 ounces.
Spanish whiting,	1 ounce.

The wax is first melted in a shallow vessel, and the mastic, finely pulverized, gradually added, and then the whiting, stirring constantly until thoroughly incorporated. The rim of wax being arranged on the plate, all superfluous portions overhanging the margins occupied by the remaining teeth are cut away; the plate may then be placed on the model and the wax again trimmed, leaving it somewhat fuller than the outer circle of the teeth, and from one to three lines longer than those immediately adjoining the spaces. The plate, with the wax attached, is then placed in its proper position in the mouth, and the patient instructed to close the jaws naturally until the remaining teeth meet; one-third or more of the crowns of the opposing teeth opposite the spaces will

thus be imbedded in the wax. A still fuller impression of the opposing teeth may be obtained, if desired, by pressing the edges of the wax down upon the crowns with the finger.

The Mesial Line.—If a series of anterior teeth are to be replaced, the mesial line of the mouth in front should be indicated upon the wax by drawing a line vertically across the latter to serve as a guide in the arrangement of the central incisors and adjoining teeth. The plate and wax are then carefully removed from the mouth and again placed upon the plaster model, the latter having been previously obtained from an impression of the parts with the plate in the mouth.

Securing the Antagonizing Models.—The method of securing the antagonizing models as practised by many, is to place the model on a slip of paper with the plate and wax upward, and the heel of the model extended from one to two inches posteriorly to form an articulating surface for the remaining portion of the antagonizing model. The added portion of plaster may be confined by a narrow strip of wax or sheet-lead extending back upon each side of the model, into which a batter of plaster is poured to the depth of ½ or ¾ of an inch. When hard, the edges and upper surface of the added plaster should be trimmed smooth, and a crucial groove, or two or three conical-shaped holes, cut in the surface of the latter to secure a fixed and definite relation of the two parts of the model. The articulating surface is then varnished and oiled to prevent the next portion of plaster from adhering; the imprints of the teeth in the wax are also oiled. The open space looking into the palatal vault should be closed with a sheet of softened wax to prevent the next portion of plaster from flowing into the cavity underneath. A batter of plaster is now poured carefully upon the exposed surface of the wax, filling the imprints of the teeth perfectly, and extending back upon the heel of the model until it acquires a depth of ½ of an inch or more. When sufficiently hard, the two sections of the model are separated, superfluous portions trimmed away, and the entire surface of both pieces glazed with varnish, and if the manipulations have been accurate, this simple contrivance will exhibit all the parts represented in plaster in precisely the same relative position which they occupy in the mouth. The writer feels, however, that a more elegant and accurate method of securing the antagonizing model,

is to take a full impression of the antagonizing teeth in wax or modeling compound. Secure a plaster cast from same and adjust the two models properly upon an articulator.

Selecting, Arranging, and Antagonizing the Teeth.—The teeth of replacement should harmonize, as nearly as possible, in size, configuration, and color, with those remaining in the mouth; and when selecting teeth for any given case, the operator should be provided with a sufficient number of sample teeth to meet every requirement, by comparison, in respect of the various tints or delicate shades of color characteristic of the natural teeth and gums. The required size and form of the artificial teeth may be determined with tolerable accuracy by a comparison with those on the plaster model, but the form or figure more certainly by a careful inspection of those in the mouth.

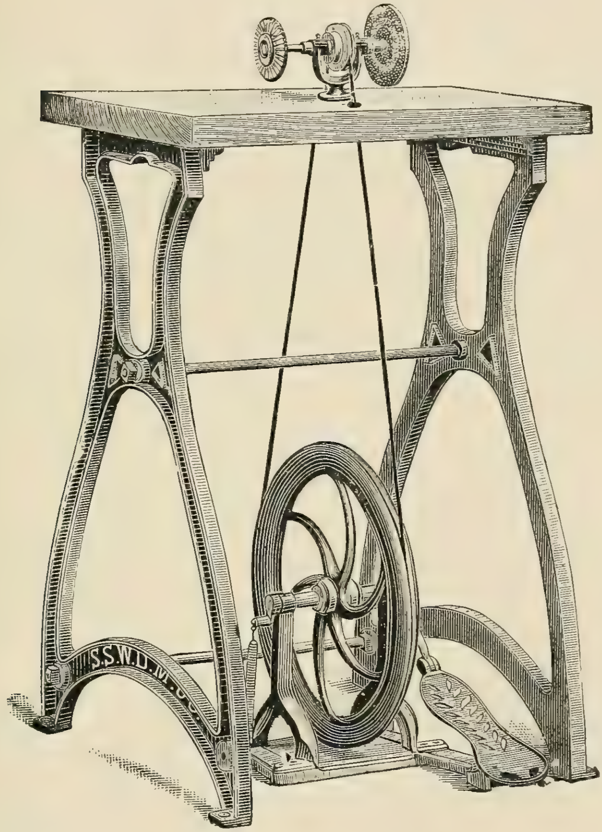
Although there are almost limitless varieties of manufactured teeth, both in respect to form and color, it is not always possible, in partial cases, to obtain such as will harmonize with the natural organs. As to form, a much closer resemblance to the natural organs in immediate relation with those of replacement can be obtained by cutting away more or less freely from the cutting edges of the incisors, and the cusps of bicuspids and molars, in cases where the natural teeth are much worn. The ground surfaces may afterward be polished with pumice on a buff-wheel, and finished with rotten-stone and oil. The exigencies of practice, in respect of partial sets, will often require the reshaping of ready-made teeth by grinding, and the original form should never be preserved at the sacrifice of utility and appearance.

To secure harmony of color in the use of manufactured teeth as found in dental depots is not always practicable. There are often conditions of the natural organs associated with decay and organic discolorations which it is impossible to match with porcelain teeth provided by manufacturers for general purposes. Such needs of the practitioner can only be adequately met by selecting the teeth and having them stained before baking at the dental depot.

Grinding the Teeth.—A greater or less change in the form of porcelain teeth will be required, in nearly all cases, in fitting them to the vacuities in the jaw; and this is more particularly so in those cases requiring the use of gum teeth. This alteration of form

is effected by grinding away portions of the tooth upon an emery- or corundum-wheel attached to the dental lathe (Fig. 89). If the edentulous portions of the ridge have suffered but little change of form by absorption, as where the teeth have been recently ex-

FIG. 89.



tracted, and plain teeth (those representing only the crowns of the natural organs) are used, the posterior portions of the base of the latter resting upon the margins of the plate will only require to be conformed to the irregularities on the surface of the base-plate, grinding sufficiently to give them the proper length and relative position, while their anterior cervical portion is permitted to overlap the edge of the plate and *rest directly upon the gum in front* on a line with the adjoining teeth. When, however, a considerable con-

cavity exists in the ridge and external border, and single gum teeth are employed to restore the customary fulness and contour of the parts, the gum portion of the tooth should be ground away on its posterior face sufficiently to restore the circle of the gum on the external border of the alveolus, and from the base of the tooth where it rests upon the plate, to admit of a proper relative position of the artificial crown; while those portions of the porcelain gum terminating at and adjoining the remaining teeth, next the spaces, should be formed with a thin retreating edge, where it laps upon the natural gum, giving to the parts, when the substitute is adjusted to the mouth, the appearance of an unbroken denture and a continuous gum. When the space to be supplied requires a series of two or more single gum teeth, the latter should be united to each other with the greatest care and exactness by grinding the proximate edges of the gum portions until the coaptation is such as to render the seams imperceptible in the mouth. In adjusting the porcelain teeth to the plate, the base of each tooth should be ground to rest as directly and uniformly on the plate as possible; for if thrown, in any degree, from the plate, the whole strain in mastication will come upon the platinum rivets, and, in a comparatively short time, the latter will either be entirely worn or cut off, or the artificial crown will be fractured on a line with the pins.

Antagonizing Partial Dentures.—In antagonizing partial sets of teeth, the indications pointed out by the customary closure of the natural organs should be followed as nearly as the form and position of the opposing teeth will permit. A changed or abnormal relation of the teeth of both jaws, however, frequently renders it difficult to effect a satisfactory adjustment of the teeth of replacement. If, in the case of the bicuspids, for example, one or more teeth in the under jaw project into a vacuity above to the extent of one-third or more of its depth, a direct closure of the substituted organs upon these, in the ordinary manner, would be impracticable without a corresponding shortening of the porcelain teeth, enforcing, in such cases, an inharmonious arrangement, entirely inconsistent with the just requirements of the case. The difficulty cited, or any of the various modifications of it, may be overcome wholly, or in part, in one of two or three ways. If the teeth encroaching upon the opposite space are very loose, as is frequently the case with those that have become elongated from

the long-continued want of an adequate opposing force, or are hopelessly carious or otherwise diseased, they should be at once removed. If they remain firm and sound, and stand slightly within the circle of the teeth of the opposite jaw, or if they have somewhat of an inward inclination in the arch, the vacuity opposite may be filled with non-masticating teeth, as a cuspid, on the lingual side of which an antagonizing cusp of gold may be constructed, allowing the point of the cuspid to lap over the labial face of the encroaching tooth or teeth; or a bicuspid, manufactured for the purpose, with the inner cusp near the base of the tooth, may be used instead. Additional room may be provided in such cases for the overlapping portion by grinding away from a corresponding point on the opposing tooth. If, however, taking the most impracticable case, the remaining teeth are sound and firm, and stand vertically in the arch, closing between the opposing teeth on a line with, or somewhat outside of, the outer circle of the latter (the elongation of such teeth being rather relative than absolute, as where it results from a mechanical wearing away of the remaining antagonizing teeth and a corresponding approximation of the jaws), the practitioner will be compelled either to submit to a mal-arrangement of the teeth of replacement by grinding away sufficiently from their masticating surface to permit an unobstructed closure of the natural organs, or if the remaining teeth are few, and poor in structure, extract them, and insert a full denture.

In view of the difficulties which so frequently present themselves in connection with the arrangement of artificial teeth in partial cases, it may not be amiss to observe that, however essential to the natural and agreeable expression of the individual an exact and harmonious arrangement of the teeth of replacement may be, this requirement should, in some degree, be disregarded whenever the necessities of the patient, in respect of the comfort and utility of the appliance or the safety of the natural organs, demand it;—to what extent appearances should be sacrificed to these considerations will depend upon the peculiar exigencies of the case, and cannot, therefore, be specifically stated. On the other hand, it may be observed that, if a sufficient number of the natural teeth are remaining in both jaws to enable the patient to perform, with tolerable efficiency, the act of mastication, the mere

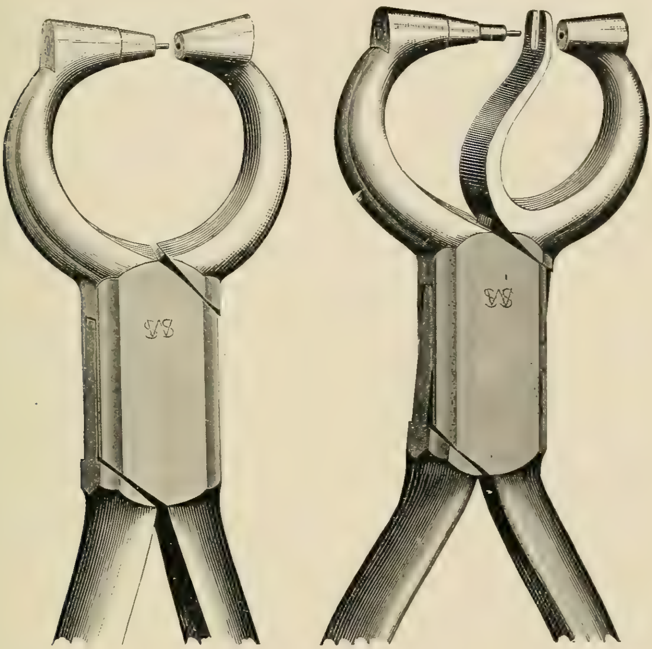
utility of the substitute in regard to the performance of this function, may be partly or wholly disregarded whenever there is sufficient reason to apprehend that the substituted organs cannot be antagonized with a view to the comminution of food without endangering the permanency and usefulness of the appliance, by necessitating the application of forces unfavorably directed.

Investing.—Having arranged and antagonized the teeth as accurately as possible on the plaster model, the piece should be placed in the mouth to detect and remedy any faultiness that may be found to exist either in the adaptation, position, or antagonism of the artificial teeth. It is then removed and imbedded in a mixture of plaster, sand, and asbestos, in the proportion of about two parts of the former and one part each of the latter. The body of the investment may be surrounded by a copper or sheet-iron band to prevent it from breaking away while adjusting the stays or linings to the teeth. All parts of the plate and teeth, except the lingual side of the former and the backs of the latter, should be incased to the depth of ½ of an inch or more, and when the latter is sufficiently hard all traces of wax from the inside should be carefully detached with suitable instruments.

Manner of Backing the Teeth.—The piece is now ready for the adjustment of stays or backings, which, when permanently united by soldering to the base and teeth, are designed to sustain the latter in position. These supports are formed from plate somewhat thicker than that used for the base, a heavier and stronger stay being necessary when they are not united laterally, and when plate teeth are used. If, however, single gum or block teeth are employed, and the stays are joined, forming a continuous band, plate one-half thicker than that used for the base will, ordinarily, impart adequate security to the attachment. A plain strip, corresponding in width with the tooth to be lined, is cut, and the end resting on the main plate conformed accurately with the file, or stone revolved by the dental engine, to the irregularities on the surface of the latter, and in such a manner as to permit the strip to take the direction of the tooth. The general form of the stay may, in the first place, be obtained by cutting a strip from a piece of gold. The points upon the stay to be pierced for the admission of the platinum pins may be ascertained by coating the surface of the former with wax softened in the flame of a spirit-lamp, and press-

ing it first against the lower pin, the point of which will be indicated by an indentation of the wax. The backing is then perforated at this point with a plate-punch, two forms of which are exhibited in Fig. 90, one armed with a tongue, which, when the plate is

FIG. 90.



pierced, forces the latter from the punch. The strip is then reapplied to the upper pin, and the second hole obtained in like manner as the first. Instead of using wax, the ends of the rivets may be stained with some pigment, which will show the points to be pierced in the backing.

The stay should be adapted accurately to the face of the tooth; it is then cut to the proper length, reaching nearly or quite to the point of the tooth, and shaped with a file and stone to the general form of the crown. When the backings are to be united, they should be formed with a shoulder at a point corresponding with the neck of the tooth, and the proximate edges below united closely by squares edges, or the latter may be beveled and made to lap upon each other. The process of soldering will be greatly

facilitated, and the piece will be more easily and artistically finished, by securing, in the first instance, a perfect coaptation of all the parts which are ultimately to be united. The sides of the holes in the stays facing the plate should now be enlarged or countersunk with a spear-shaped or conical bur-drill, and when applied to the teeth the projecting ends of the platinum pins are cut off even with the backings, and then split and spread apart with a small chisel-shaped instrument; a head will thus be formed to the rivets when solder is fused upon them, which will prevent them from drawing from the backings.

The Soldering Process.—All the lines of union between the several pieces should next be well scraped, exposing a clean, bright, metallic surface to the solder (see Principles of Soldering, page 65); the seams are then coated with borax, ground or rubbed in clean, soft water to about the consistency of cream;* after which small pieces of solder are placed along the joints and over the points of the platinum pins. The piece thus prepared is now placed in the furnace or ordinary fireplace, in order to heat the entire mass preparatory to soldering. The fuel most proper for this purpose is charcoal, either alone or combined with coke, the latter being preferable for the reason that charcoal alone is more quickly consumed, and burning away more rapidly underneath, the piece is more liable to drop to the bottom of the furnace. The fuel should be broken into small pieces and built up around the borders of the investment in order that all parts of the latter may be uniformly heated. The heating process should be conducted gradually, for if the piece to be soldered is subjected suddenly to a high heat, the plaster will be displaced by the too rapid evolution of vapor, and the integrity of the porcelain teeth will be endangered. The piece may be allowed to remain in the fire until the plate acquires a visible red heat, when it should be removed, placed on a suitable holder, and the solder fused with the blowpipe. A broad, spreading flame should first be thrown over the entire surface of the plate and border of the plaster, until the temperature of the entire mass is nearly that required to fuse the sol-

* Slate is often used for this purpose, but is unfit, as, in rubbing the borax, loosened particles of the former become mixed with the latter and impede the flow of the solder, and becoming entangled render it unclean and porous. Ground glass or a porcelain slab is the best for the purpose.

der, and which is indicated by the latter settling and contracting upon itself. *A small pointed flame, carefully controlled, with very slight pressure upon the bellows,* may then be concentrated upon a particular point, as at the heel of the plate on one side, passing round from tooth to tooth until all the parts are completely united and the solder is well and uniformly diffused.

Having united the teeth to the plate, the piece may be allowed to cool gradually, or it may be plunged, after the lapse of a few minutes, into boiling water without risk of injury to the teeth. When cool, the plaster is removed and the plate placed in the *acid bath* (a solution of equal parts of sulphuric acid and water), where it may be allowed to remain until the discoloration of the plate and the remains of the vitrified borax, incident to the soldering, are removed, or it may be put into a small copper vessel, partly filled with the same solution, and boiled for a few minutes. After removing the plate from the acid, it should be boiled for five or ten minutes in a solution of chlorid of soda, or common salt and water, to remove thoroughly all traces of the acid.

The Finishing Process.—Superfluous portions of solder are now to be removed, and this at first may be more quickly accomplished by the use of burs and stones of various forms and sizes attached to the dental engine. After the rougher and more redundant parts are thus cut away, any remaining irregularities upon the surface may be further reduced with sand-paper or emery-discs. Then, with a rapidly-revolving brush attached to a foot-lathe, the final polish or luster may be imparted by the use, first, of finely-powdered pumice-stone, followed by Spanish whiting, or prepared chalk, and then rouge mixed with water or alcohol.

In the final adjustment of the finished piece to the mouth, and after any additional change in the form of the teeth necessary to secure the most perfect antagonism has been made, the patient should, in all cases of partial dentures, receive explicit directions in regard to the general care and management of the appliance and the remaining natural teeth. Ordinarily, there will be but little difficulty experienced by the patient in the immediate and successful use of a substitute supported in the mouth by clasps, or any equivalent means; but in the case of atmospheric-pressure plates, the patient should be candidly advised of the probable want of stability incident to the first use of the appliance, and the

consequent annoyance which in many cases follows its occasional displacement in mastication until such time as the adaptation of the several parts to each other are perfected, and the patient has acquired a habit of controlling and directing the forces applied to the substitute. The time necessary to accomplish these results will depend much upon the form and condition of the mouth, a favorable or unfavorable antagonism, the adaptation of the plate, and the aptitude and temper of the patient. It will be prudent and but just to the patient to state that the complete utility of an appliance sustained by atmospheric pressure will not, probably, be realized in less time than from one to two weeks, and this estimate of time, in a majority of cases, will be fully justified by experience in the cases under consideration.

The importance of thorough and absolute cleanliness of the substitute and remaining natural teeth, and the reasons therefor, should be clearly stated; and the comfort, utility, and durability of the artificial fixture, as well as the safety of all the remaining natural organs, will depend, in a great measure, upon the fidelity of the patient with respect to the observance of these injunctions. In those cases especially where clasps are used, the substitute should invariably be removed after each meal and cleansed, while the teeth clasped should, at the same time, be freed from deposits of food or other foreign substances with a brush, and other means usually recommended for the purpose.

CHAPTER XIX.

ENTIRE DENTURES.

Preliminary Observations.—Before proceeding to describe in detail the mechanical processes or manipulations concerned in the construction of entire dentures, unnecessary repetition will hereafter be avoided by first considering, in this place, certain underlying principles and fundamental requirements which are common to all the various distinct methods of replacement in edentulous cases. This preliminary treatment of the subject may be comprehended under two general heads: (1) A consideration of the principles and attendant phenomena involved in the application of the forces commonly utilized as a means of attachment; and (2) esthetic requirements in the selection and arrangement of the teeth of replacement. There are two forces in nature utilized in the retention of entire dentures, notably in upper cases,—*atmospheric pressure* and *adhesion*. We shall consider, first, some of the attributes and phenomena characteristic of these forces, and then endeavor to make some practical applications of them in elucidation of the subject in hand.

Adhesion may be defined as the force by which the particles of different bodies stick together, in contradistinction to cohesion, which is the force that holds the molecules of the same body together. There are several kinds of adhesion, but our present purpose only contemplates those which relate to the adhesion of solids to solids, and fluids to solids.

The adhesion of solids to solids is illustrated by pressing together two plates of glass or metal having perfect occluding surfaces, when they will be found to adhere with force enough to support not only the lower plate, but some additional weight. Very delicate tests have been made by which the adhesive force is accurately measured. An important practical fact, in this connection, has been well established, which has a direct bearing on the subject we are considering, namely, that the tenacity with which such plates adhere to each other is not in any manner due

to, but wholly independent of, any force exerted by the pressure of the atmosphere, as was supposed by some of the earlier experimenters. The fact alluded to was conclusively proven by suspending the plates, the lower one of which was weighted, in the vacuum of an air-pump, in which case the plates still remained adherent. Examples of this adhesive force as affecting solids might be almost indefinitely multiplied.

The force of adhesion of solids to liquids is not less pronounced. When a polished plate is suspended on a delicately constructed balance, and brought carefully down on the surface of a liquid, completely excluding the air, adhesion will take place, the force of which will be modified by the kind of liquid in contact with the plate. It has been ascertained by careful experiment that the adhevise force of a polished plate of agate, one inch in diameter, in contact with water, is 25 grains; sulphuric acid, 29; hydrochloric acid, 25; solution of saltpeter, 23; of lime, 21; almond-oil, 16; petroleum, 16; turpentine and alcohol, 15; ether, 10. Where, as often happens, drops of the liquid adhere to the plate when separated, it proves that the adhesion of the liquid to the solid is stronger than the cohesion of the liquid itself, and that the numbers obtained in these experiments express rather the cohesion of particles of the liquid which were separated by the weight, than the adhesion of the plate to the liquid. As in the case of adhesion of solids to solids, it was formerly claimed by some that adhesion in these cases was due to atmospheric pressure, but that was disproved in the same manner as the other. Perfect exclusion of air is essential to the operation of this force, a suggestive fact in connection with the adaptation and retention of entire dentures.

Atmospheric pressure is that force exerted by the air by reason of its gravity, one of its mechanical properties being *weight,* which renders it amenable to the same law of attraction that affects all other bodies similarly endowed. It exerts a pressure not only downward, but, according to the law of fluids, sideways, upward, etc., as by the mobility of fluid particles any pressure is transmitted in all directions. Superadded to gravity is its elastic force, a property which, like all gaseous bodies, it possesses in a remarkable degree. This property is familiarly demonstrated by filling a bladder with air and exposing it to rarefied air at a great height. The external pressure of the atmosphere at such an altitude being

diminished, the air within tends to expand to the same degree of rarity as that without, and with such force as to burst the bladder. The partial displacement of air by compression within a diving-bell by the pressure of water at a low depth, and the forcible expulsion of the intruding water as the bell is brought to the surface, not only illustrates its elasticity, but its impenetrability also, or its property of preventing another body from occupying the space where it is. There are many other examples of the pressure of the atmosphere and the force exerted by virtue of its elastic property, but those of most interest and consequence to the prosthetic specialist relate to their effects on the human organism. It is estimated that the force exerted by the pressure of the atmosphere on the body of a medium-sized man must be about 15 tons, a force sufficient to crush and destroy him if applied only to the external portions of the body. Such pressure, however, is neutralized and rendered harmless by counter-pressure from within; a result due to the elasticity of the air, which exerts a force everywhere and *in all directions alike,* from the external parts inwardly, and from those within outwardly. The tendency in nature everywhere is toward the establishment of an equilibrium of atmospheric pressure, and when these balanced forces are disturbed, unusual and characteristic phenomena follow. If, as in the case of "cupping," the external pressure of the atmosphere is removed by the formation of a vacuum, the elastic force of the air operating from within, and meeting no counter-force at the point cupped, will, by virtue of its inherent elastic energy, force the soft tissues into the body of the cup as the result of this tendency to an equilibrium. The latter occurs as soon as the unoccupied space forming the vacuum is filled with the tissues, when, the accustomed balance of forces being restored, the cup will loosen and fall off. If the disturbance of the equilibrium of forces acting from without and within is general, as in the case of an aëronaut in a balloon at great heights, the result of this tendency may, and often has, put life in jeopardy by expansion of the internal organs. On the contrary, the body exposed to greatly increased external pressure of the air, as when the latter is condensed in the diving-bell at low depths, or in caissons employed in forming a foundation of subaqueous structures, the results may be equally harmful or fatal by compression of the internal organs.

The Application of Atmospheric Pressure and Adhesion in the Retention of Artificial Dentures.—The general proposition that, in the case of entire dentures, retention of the plate in place by atmospheric pressure presupposes a *vacuum* obtained by exhaustion of the air from a *cavity,* of whatever form, located somewhere between the plate and the mucous surfaces on which the latter rests, and that such cavity implies *space.* Whenever, therefore, a dental appliance of the kind under consideration is in *uniform contact at all points* with the parts in the mouth, it is manifestly improper to speak of it as being held in place by atmospheric pressure, or to designate it as an "atmospheric-pressure plate." Uniform contact implies perfect continuity between the plate and the parts on which it rests, and this necessarily precludes the idea of space, and without space a vacuum is impossible, and in the absence of the latter, the atmosphere, as we shall endeavor to show, is wholly inoperative as a retaining force. To comprehend the matter intelligently, we must not lose sight of the important central fact that the atmosphere, in its undisturbed condition, exerts an equal pressure in all directions, a property largely due to its elasticity, and that in obedience to this law, in its operation upon the human organism, the force exerted from without inward is exactly counterbalanced by the same force acting from within outward, thus establishing an equilibrium of the counteracting forces, and a consequent neutralizing of pressure at the surface. This equalized force is an essential condition of human well-being and of human life, as has been heretofore stated and demonstrated by examples. The absurdity, therefore, of attributing the retention of substitutes, adapted in this manner to the mouth, to the pressure of the atmosphere is apparent. There can be no reasonable question but that substitutes so applied are held *in situ* by that force manifesting itself in *adhesion.* In all cases where the plate or other base is accurately adapted to the entire mucous surfaces, and the air thoroughly excluded, the essential conditions favoring its retention by adhesion is secured, namely, perfect contact of a solid with the fluids with which the mucous surfaces are constantly bathed.

Let us now consider, as briefly as possible, the manner in which air-pressure acts as a retaining force when applied to cavity-plates, and in the same connection some of the phenomena resulting from such action.

When a plate, provided with a cavity or chamber, is applied to the mouth, two concurrent phenomena are observed: the immediate and forcible attachment of the plate to the mucous surfaces, and the obtrusion of the soft tissues into the space from which the air has been exhausted. The first is due to the external pressure of the atmosphere, the latter to the same force acting from within. Here, again, it is essential to remember the fundamental fact that atmospheric pressure acts equally in all directions. The phenomena to which attention has been called, in the case of an applied cavity-plate, are the result of a disturbance of these ordinarily balanced forces. When a vacuum, partial or complete, is formed by exhaustion of air from the chamber, the external pressure of the air meeting with a diminished counter-resistance from within, by reason of the vacuum, forces the plate against the parts, while at the same time the atmospheric pressure acting from within outwardly, meeting with a like diminished resistance at the surface embraced within the limits of the chamber, forces the soft tissues into the chamber. Thus we find displayed the universal tendency to an equilibrium of atmospheric pressure, and a practical illustration of nature's proverbial abhorrence of a vacuum.

It is not probable that a perfect vacuum is ever secured by the means ordinarily employed by the patient, unless, perhaps, in the case of very shallow cavities. The moment any portion of the contained air is exhausted, there is instant and forcible pressure of the plate upon the soft tissues immediately surrounding the chamber, acting as an effectual mechanical impediment to further egress of air. The power to exhaust is therefore self-limited, and a partial vacuum only the result. Sooner or later, in a large percentage of cases, even this limited power is rendered inadequate to secure any degree of exhaustion by the intrusion of tissues which, by long-continued and unrelieved pressure, become in time permanently hypertrophied.

The completeness with which the chamber may become filled with soft tissues will depend partly upon the form of the cavity, and partly upon the abundance and mobility of the tissues. If the cavity is constructed with vertical walls and sharply defined margins, the latter, by becoming quickly imbedded, will act as a mechanical obstruction to any ready, sliding movement of the

tissues into the chamber. Plates so constructed adhere with greater tenacity and more persistency, especially when the parts embraced are rigid and immobile; but it is at the cost of the maximum of injury which cavity-plates are capable of inflicting, and which is often, in extreme cases, characterized by rupture of the superficial vessels, wounding of the mucous membrane, and in active inflammatory conditions which not infrequently involve the adjacent tissues. More ready entrance of the tissues into the chamber occurs where the edges of the latter are rounded and the walls slope toward the center, as in the case of those that are swaged, but this form is at the expense of the retaining force, since atmospheric pressure from without is always diminished in proportion as the cavity becomes filled in with the tissues, and ceases entirely when a vacuum no longer exists. The facility with which the chamber will become occupied is greatly increased when the soft tissues are in excess, their softness and mobility offering but a feeble resistance to the atmospheric pressure from within, in which case the cavity soon becomes partly or wholly occupied by them, and what retaining force was originally secured by atmospheric pressure will, in a comparatively short time, become greatly impaired or wholly inoperative.

When it is remembered how transitory are the uses of so-called "air-chambers," and how capable, under ordinary circumstances, they are of inflicting serious injury upon the delicate tissues of the mouth, there would seem to be no sufficient reason or justification for their employment, except possibly in rare and exceptional cases. *Experience has amply demonstrated that equally secure and much more enduring attachment of the substitute may be obtained in the utilization of adhesive force alone*—a means of retention wholly exempt from the harmful consequences that too often follow the application of atmospheric pressure consequent on the formation of a vacuum.

There are, however, many cases where spaces or cavities may be employed to advantage for the purpose of securing, through the temporary pressure of the atmosphere, increased stability of a dental appliance subjected to the forces applied in mastication. There are associated conditions of the mouth which, in their normal and undisturbed relation to each other, prevent, to some extent, a uniform or equalized bearing of the substitute upon the

parts to which it is applied. These conditions relate to unequal hardness and softness of the tissues, and a consequent inequality of resistance to pressure. Thus, if the ridge is relatively softer and more compressible than the central portion of the arch, the plate, when force is applied over the ridge, will "ride" upon the central portion, as upon a pivot-point, and thus raise or detach the plate from the ridge on the opposite side. This is called "rocking" of the plate, the action being illustrated in the sport familiarly known as "see-sawing." *The remedy for this consists in securing a space between the central portion of the roof of the mouth and the corresponding portions of the plate, so that when the substitute is applied to the mouth and the air exhausted, the greatest pressure will be expanded upon the ridge, and, by compression, equalize the resistance.* This space, when the plastic vegetable bases are used, is obtained by scraping away from the impression at the required points; raising the central portions of the plaster model with sheet-lead of proper form and thickness; or by trimming away from the palatal surface of the finished piece. In the case of swaged plates, the shrinkage of the metallic die will ordinarily afford the required space.

In cases where there is approximate uniformity of hardness of the ridge and central line of the arch extending antero-posteriorly, associated with soft and yielding tissues filling the fossæ on either side and extending some distance up the lateral walls of the arch, it is customary, in order to equalize the pressure of the plate, or rather, to secure uniformity of resistance to such pressure, to scrape away from such portions of the plaster model as correspond with the softer tissues, thus securing in the finished piece an increased convexity or fulness which, on application of the substitute, exerts a compressing force at such points, superadded to that obtained either by atmospheric pressure or adhesion. It may be reasonably objected to this mode of procedure that the augmented compressing force thus applied, being continually antagonized by the inherent elastic force of the tissue pressed, must inevitably tend to weaken the attachment of the substitute, and that such repelling force will continue to act, in a diminishing degree, no doubt, until, from long-continued pressure, such of the tissues as are not displaced will become absorbed or atrophied. The objection is emphasized by the further fact that, in such

cases, the absorption is always preceded and accompanied by forcible displacement of superabundant tissue into the soft palate, inducing more or less irritation and ultimate chronic tumefaction of the displaced tissue at the posterior margin of the plate. The prevalent fallacy that the tissues thus subjected to pressure are *condensed* thereby has been considered in the initial portion of the chapter on Impressions.

No device will, we believe, so effectually and satisfactorily fulfil the requirements of the cases last mentioned as the one that provides for displacement of the tissues within the limits of the plate itself. This may be done by securing a graduated space, including a large part of the palatal vault. This space should not be in the form of a cavity with defined walls, but should slope gradually toward the periphery in such manner that its boundaries shall be indistinguishable. By a graduated cavity is meant that, wherever the soft tissues are in excess, there should be a corresponding depth of space to provide for such varying degrees of displacement as are essential in the procurement of an equalized resistance to the pressure of the plate. By this method there is not only no injury or objectionable deformity inflicted, but the attachment of the substitute, instead of being impaired, as in the other method, is maintained at first by the full and unobstructed force of atmospheric pressure, and when, finally, the required displacement of tissue is accomplished, by a filling-in of the space, the best practicable adaptation is obtained, and the future stability of the substitute as perfectly provided for as is possible with the resources at our command.

Esthetic Requirements in the Selection and Arrangement of the Teeth of Replacement.—In selecting teeth for an entire upper and lower denture, the special requirements in regard to size, form, and color, will depend in a great measure upon the complexion, age, sex, and general configuration of the face of the patient. Every separate denture, therefore, that is constructed in strict conformity with a faithful interpretation of the special requirements of each individual case, will be characterized by shades of difference in color, form, size, and arrangement of the teeth of replacement. The indication in the fulfilment of such requirements, broadly stated, is, that such selection of the teeth, in any given case, should be made as will, when suitably arranged, most perfectly reproduce the lost proportions of the facial contour, and restore the characteristic expression of the individual.

To accomplish this with fidelity will require a higher order of intelligent discrimination, and a broader art culture than is required in cases where the operator is aided by comparison of the artificial with remaining natural teeth, as in partial dentures. In the present case he has no resources except those that come to him through a critical and conscientious study of the laws of harmony as displayed in the typical forms of dentures associated with individual physiognomy and temperament. Says Dr. Eben M. Flagg, a thoughtful writer: "We find that the necessity for art in dentistry exists in proportion to the hopelessness of the case. The greater the amount of lost tissue to be replaced, the greater the knowledge of *natural* form required to properly effect its replacement. Beginning with the restoration of portions of teeth through gold fillings, we come to the loss of the entire crown, and, finally, to that last resort, the replacement of the entire denture. Knowledge of form and color, of expression, character, and effect, now becomes imperative to the dentist. To relieve the condition of his patient, the art of the sculptor and colorist must be studied with more care than many of us are wont to give it, while a knowledge of temperament and physiognomy becomes an important element in our work."

"No matter how anatomically correct," observes one of the most intelligent contributors to the literature of esthetic dentistry, the late Dr. James W. White, "or how skilfully adapted for speech and mastication an artificial denture may be, yet, if it bear not the relation demanded by age, temperament, facial contour, etc., it cannot be otherwise than that its artificiality will be apparent to every beholder.

"This law of correlation, harmony, running through nature, attracts and enchants us by an infinite diversity of manifestations; the failure to recognize its demands by art is correspondingly abhorrent to our sensibilities.

"In the social gathering, a lady who appreciates the law of harmony delights the eye by the taste displayed in her attire; another, though more elaborately and expensively adorned, yet failing to harmonize the details of her costume, attracts attention only by the impression of incongruity. We hear frequently from a lady who is selecting a bonnet, or from a gentleman purchasing a hat or other article of wearing apparel, the question to a friend: 'Does this become me?' the query indicating the recognition that, however exquisite the material or excellent the manufacture of

the article, a certain law of fitness prevails, the failure to comply with which makes the wearer appear ridiculous. We meet in the street one the color of whose hair we expect, by the law of association, to be fair or sandy, and if otherwise, a wig or a dye is instantly suggested.

"There is a relation between the physical form and the voice, from which we are led to infer in advance the character of the tones which from any given individual may be expected. This law of association in any case having led us to anticipate a bass voice, the anomaly, should a falsetto greet us, is almost ludicrous.

"There is a similar relation between other physical characteristics and the teeth. A broad, square face or an oval; a large, coarse-featured man or a delicately-organized woman; a miss of eighteen or a matron of fifty; a brunette or a blonde—these and other varieties present as many differing types, with teeth, in size, shape, color, density, etc., corresponding. If, then, teeth, correlated in their characteristics to those which nature assigns to one class, be inserted in the mouth of one whose physical organization demands a different order, the effect cannot be otherwise than displeasing to the eye, whether the observer be skilled in perception, or intuitively recognizes inharmony without understanding the cause."

Written or verbal instructions can do little more than present general principles governing the selection of teeth for any given case. The completeness with which the requirements of individual cases are fulfilled will largely depend upon the operator's art intuitions, and his ability properly to interpret and apply the basal facts which an intelligent study of the relation of physiognomy and temperament to the teeth has revealed. The relations of the latter to the teeth have been clearly and fully set forth in tabulated form by Dr. J. Foster Flagg, which we herewith append. The first table relates to the basal temperaments, namely, bilious, sanguineous, nervous, and lymphatic, and their general indications; the second, to the teeth as indicated by temperament.

A careful study of these tables, the subject-matter of which is by far the most valuable contribution that has yet appeared in connection with the subject under consideration, will furnish a helpful means of solving one of the most difficult problems in prosthetic practice.

The following editorial, by Dr. James W. White, on "Temperament in Relation to Teeth," suggested, doubtless, by Dr. Flagg's tables, embodies not only a discussion of the general subject of temperaments, but some forcible and striking commentaries on the importance and value, esthetically considered, of the indications furnished by temperamental characteristics in the intelligent choice of artificial substitutes for special cases. The importance of the subject to which the article relates will justify its introduction here without abridgment:

"The animal kingdom is divided into sub-kingdoms, classes, orders, families, genera, species. A further or sub-division includes in minor groups individuals whose salient characteristics are correspondent or similar. Thus every living creature has certain physical peculiarities by which its position in this classification is determined. Man, as the head of the animal kingdom, besides having his place in this general scale, is distinguished by a still finer classification under the denomination of temperament —an association of several distinguishing characteristics, such as size and form of body, complexion, color of the eyes and hair, and, to a certain extent, the disposition and character of the individual.

"Temperament may be defined as a constitutional organization, depending primarily upon heredity—national or ancestral—and consisting chiefly in a certain relative proportion of the mechanical, nutritive, and nervous systems, and the relative energy of the various functions of the body—the reciprocal action of the digestive, respiratory, circulatory, and nervous systems. The stomach, liver, lungs, heart, and brain—digestion, assimilation, respiration, circulation, and innervation—are all factors in the differentiation of temperament; and according to the congenital predominance of one or the other, and the relative activity of these functions, is the modification of the characteristics of the individual which assigns him to one or other of the basal or mixed temperaments. Each temperament is the result as well as the indication of the preponderance of one or another of these systems, and of relative functional activity.

"A perfect equilibrium of the different systems is rarely, if ever, presented in any individual. One having a balance of all the temperaments would be temperamentless, or of no special

temperament. It is difficult, in some cases, to decide positively to which variety a special case belongs, the several temperaments being combined and blended in such ever-varying proportions. Not infrequently the indications are even contradictory, and the blending of several temperaments requires a nice discrimination to define the admixture. The primary elements of temperament are susceptible of such manifold combinations; the determining forces are so complex, and our knowledge of their comparative values is so limited, that no rule can be given which will not fail in numerous instances to apply in all respects to individual cases; but that there is a general relation between constitutional qualities and external signs does not admit of question.

"Temperaments are readily divisible into four basal classes—bilious, sanguineous, nervous, and lymphatic (see tables); then again into sub-classes of mixed temperaments—a combination of two or more of the primary divisions. In these combinations one or other of the so-called basal temperaments predominates, and a compound term is used to express the complexity, as, for instance, the nervo-bilious, signifying that the bilious base—the foundation temperament—is qualified by an admixture of the nervous element, and so throughout the series. Twelve varieties of temperament, in addition to the four basal, may thus be designated by the combination in pairs of the original four. The admixture of the peculiarities of three or of all four of the basal temperaments results in what are denominated respectively ternary and quaternary combinations, which call for nice discrimination in diagnosis; but even such complexities are registered in the size, form, and color of the dental organs.

"The value of a practical application of the study of temperament in the practice of dentistry is apparent. That the relation of the teeth to temperament is, as a rule, ignored by those engaged in prosthetic dentistry is evident in the mouths of a majority of those who are so unfortunate as to be under the necessity of wearing substitutes for lost natural dentures.

"A certain law of harmony in nature between the teeth and other physical characteristics necessitates respect to size, shape, color, and other qualities in an artificial denture, in order that it shall correspond with other indications of temperament; and if teeth correlated in their characteristics to those which nature

THE FOUR BASAL TEMPERAMENTS AND THEIR GENERAL INDICATIONS.

	Indications.	Bilious.	Sanguineous.	Nervous.	Lymphatic.
1	General form or Framework.	Tall, angular, massive; square built.	Full, firmly-rounded contour development; medium height; robust.	Delicate; slight, but erect and well-proportioned.	Bulky; heavy; clumsy.
2	General Movement	Steady and persistent.	Full, graceful, and easy.	Rapid, but fitful in movements; quick in the sense of frequent.	Unsteady; uncertain; loose-jointed; sluggish; deliberate.
3	Muscular Development.	Knotty; prominent; hard; tense; well-developed.	Well-rounded and graceful.	Well-defined; light, but sinewy.	Large, but flabby and ill defined.
4	Chest or Thorax.	Square and capacious; good expansive power.	Well-rounded and capacious; deep and full.	Not broad but prominent; very expansive.	Large, but lacking in expansive power.
5	Voice, Quality of	Strong, but inclined to harshness.	Smooth: sonorous; full.	Not very strong, but clear, penetrating, and ringing.	Poor in vibration, but often soothing and quieting in quality.
6	Complexion and Skin	Brownish-yellow; tense and inclined to roughness; dry.	Florid; smooth; warm and dry.	Abounding in grayish tints; fine in texture, and elastic.	Pallid; muddy; moist and cold.
7	Favorable Endowments or Advantageous Indications	Strength; endurance; fortitude; decision; firmness.	Hopeful; enthusiastic; aspiring.	Remarkable recuperative power.	Gift of self-control; calm; cool; quiet.
8	Unfavorable Endowments or Disadvantageous Indications	Inclined to melancholy; despondent.	Lack of self-control; impetuous.	Mental fitfulness, and inclined to rapid degeneration or retrogression.	Inertia; low recuperative power in pathological conditions.
9	Cranial Contour.	Square forehead and cranium.	Rounding and full forehead and cranium.	Cranium inclined to preponderate over face.	Forehead low and not shapely; often receding and flat.
10	Facial Contour	Angular; high cheek-bones.	Rounded and full.	Delicately oval.	Flat-faced.
11	Hair	Black, and closely curling; inclined to coarse.	Golden to light chestnut; slightly wavy.	Brown; wavy; fine.	Coarse; straight; drab, and sparse.
12	Eyes	Average size; black, and strong in expression.	Large; full; clear; round; blue.	Above average in size; dark brown; perceptive in expression.	Small, expressionless, and grayish.
13	Eyebrows.	Heavy; strong and straightly marked.	Fairly arched; not well-marked.	Well-marked and arched; finely penciled.	Sparse and indistinct.
14	Nose	Strong in outline; Roman.	Straight and shapely.	Finely cut and often delicately aquiline in form.	Flat; alæ heavy.
15	Lips	Large, and brownish-purple.	Ruddy and full.	Fine and grayish-pink.	Large, but not shapely, and pale.

THE TEETH AS INDICATED BY TEMPERAMENT.

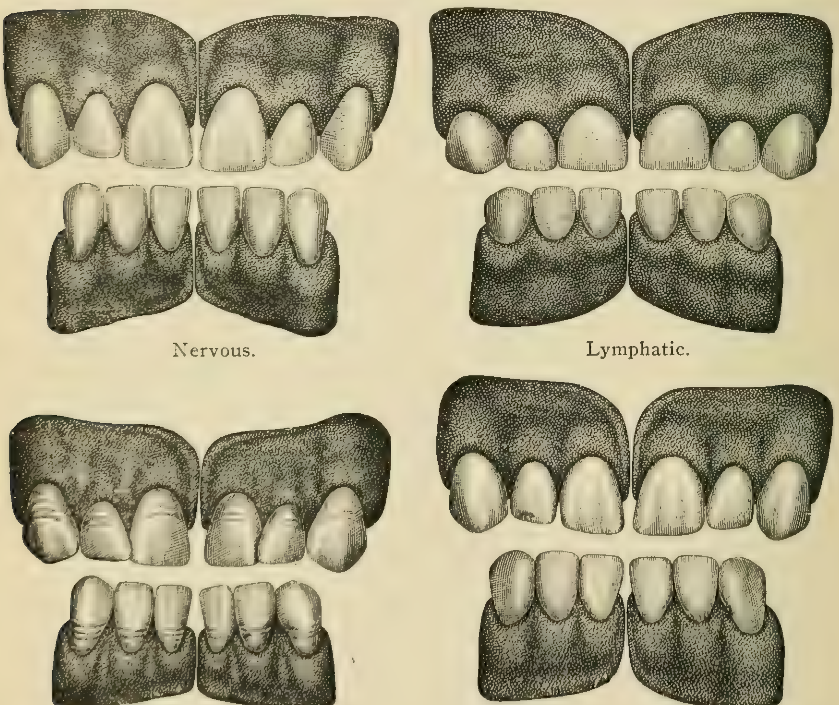
General Divisions.	Bilious.	Sanguineous.	Nervous.	Lymphatic.
General Color and Quality of Color, . .	Bronze-yellow, with strength or power of coloring.	Cream-yellow, and inclined to translucency.	Pearl-blue or gray; inclined to transparency.	Pallid and opaque, or muddy in coloring.
General Form, ...	Large and inclined to angular; rather long in proportion to breadth.	Well proportioned; abounding in curved or rounded outlines; cusps rounding.	Length predominating over breadth; fine, long cutting edges and cusps.	Large, but not shapely; breadth predominating over length; cusps poorly defined.
Surfaces of the Teeth, . .	Inclined to transverse ridges, and abounding in strong lines; neither brilliancy nor transparency of surface, but slight translucency.	Smooth, or nearly so; elevations and depressions rounded; cutting edges and cusps translucent. Fair degree of brilliancy.	Brilliant and transparent depressions and elevations; abounding in long curves.	Surfaces of incisors devoid of depressions or elevations; opaque and dead in finish, even to cutting edges.
Articulation, ...	Firm and close; well locked.	Moderately firm; jaw inclined to rotate in mastication.	Very long and penetrating.	Loose and flat.
Gum Margin or Festoon, ...	Heavy and firm, but inclined to angularity.	Round and full, as regards both breadth and depth.	Delicate, shapely, and fine; oval in curve.	Thick and undefined in shape.
Rugæ, ...	Heavy and rugged in shape; squarely set.	Numerous and graceful in outline; not heavy, but well rounded.	Close, not numerous; small and long.	Sparse and flat.

assigns to one temperament be inserted in the mouth of one whose physical organization demands a different type, the effect is abhorrent. The artificiality of artificial teeth is the subject of remark by those who have little or no conception of the reason therefor—simply an instinctive appreciation of the incongruity and unreality. It is indeed rare to see a case in which there is occasion for a moment's hesitation as to the fact of replacement. There is no dental service that, from the esthetic standpoint, is, as a rule, so illy performed as the prosthetic. Thousands of dentures are constructed which serve the needs of the wearer for speech and mastication, but which are, nevertheless, deserving of utter condemnation as art productions. More attention has been paid to the best methods of restoring impaired function—securing comfort and usefulness in artificial dentures—than to a correlation of the substitutes to the physical characteristics of the patient.

"What is needed is such an appreciation of the law of correspondence that the dentist can cipher out, as by the rule of three, the character of teeth required in the case of an edentulous mouth with the same precision as the comparative anatomist can, from a single bone, indicate the anatomical structure of the animal to which it belonged. The probability is that in many, perhaps in most, of the cases of incongruous artificial dentures the fault is not in carelessness or indifference of the dentist, but in failure to recognize the requirements of temperament. A certain family resemblance to each other in a set of teeth is considered essential, but the adaptability of the set as a whole to a given case should be esteemed of even greater importance. Especially is there a notable failure to recognize the color demanded by form. A set of teeth in which not only the relative length and breadth, but every line and curve, characterize it as belonging to a certain temperament, is, in contravention of every law of correspondence, made of a color which was never found in nature associated with such forms. Thus we see constantly such incongruities as the association of the massive tooth of the bilious temperament with the pearl-blue color belonging to the nervous temperament, and the long, narrow teeth of the nervous temperament of bronze-yellow color never seen in the mouth of any but those of a bilious temperament.

"The trouble is not with the manufacturers; they supply the demand. The fact is, the requirements of the law of correspondence have not been sufficiently studied by the profession. The first study of the dentist who aspires to the dignity of artist, when proposing to replace a lost denture, should be how to restore the natural appearance of his patient, and this can only be effected through an appreciation and observance of the temperamental characteristics and the law of correspondence or harmony. Age and sex may somewhat modify the requirements in a given case,

FIG. 91.



Nervous. Lymphatic. Bilious. Sanguineous.

but the basal fact on which he should proceed is temperament. A failure to recognize its demands will result in failure—from an esthetic standpoint."

Selection and Arrangement of Artificial Teeth.—A knowledge of the distinguishing characteristics of the various temperaments and the style of teeth which conform to nature's type in the phys-

ical organization (see Fig. 91) marks the difference between the dental mechanic and the dental artist; and the fulfilment of the highest art conceptions in the construction of entire dentures is far from being complete with the mere selection of teeth in conformity with temperamental and other indications. The essential preliminary step is concerned chiefly with the form and color of substitutes, but the highest attainments in the art of replacement can never be attained without an intelligent perception of the esthetic requirements which have inseparable relation to the *arrangement* of the teeth selected in strict conformity with the same law of harmony or correspondence that applies to form and color. The art of arrangement is scarcely less difficult, and certainly not less important, than the art of selection, and equal judgment and discrimination will be required to effect such an adjustment of the teeth as will most faithfully serve to restore the facial contour and characteristic expression of the individual. This will, in most cases, necessitate some deviation from the uniformly symmetrical or ideal relation of the teeth to each other characteristic of perfect regularity of arrangement, and which rarely exists except in connection with a perfectly balanced development of the jaws and teeth, a condition which may be said to be almost phenomenal.

The kind or degree of displacement of any particular tooth or teeth to effect such irregularity of arrangement as would best reproduce the customary expression of the individual in any given case, cannot, of course, be here indicated. The operator is necessarily thrown upon his own resources in determining, in this respect, the necessities of individual cases. Generally speaking, the changed relation of the teeth is, in most part, confined to the six anterior teeth, above and below, as they are most largely concerned in expression; but it may often be extended to the bicuspids and molars, which may be displaced within or without the arch, or given an oblique position, with here and there interdental spaces, some of which may be wide enough to suggest the loss of the natural teeth at intervals. The central incisors may be made to overlap each other, with the laterals in normal position; or the latter may be given a position inside of the circle, which will give a relative prominence to the centrals and cuspids, or they may be partially rotated while retaining their regular position in the arch,

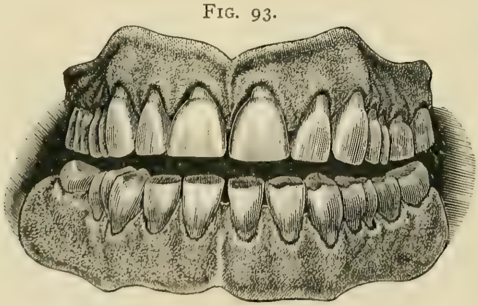
or be made to overlap or underlap the centrals, in which case the latter may be made to diverge somewhat from each other at the points, leaving some space between them. Figs. 92, 93, 94, and 95, are given as suggestive both in the selection of teeth and their arrangement.

There is scarcely any limit to the capability of effecting malpositions of the teeth of replacement, and this is especially true of

Fig. 92.

those forms of substitution known as continuous-gum work, and in the use of celluloid, either process, by admitting of the use of single, plain teeth, affording unlimited opportunities for the optional placement of the teeth. In the use of sectional gum teeth, many of the forms of dental irregularity have been faithfully

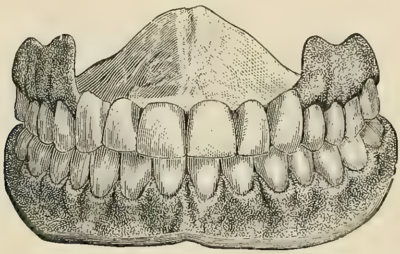
Fig. 93.



reproduced by manufacturers, and, when selected with an intelligent apprehension of their fitness for any particular case, will meet the ordinary wants of the practitioner in the use of rubber, or a metallic plate-base with rubber or celluloid attachment. The minimum of capability in effecting irregularity of arrangement is attached to soldered work, where, as is usually the case, single gum teeth are employed.

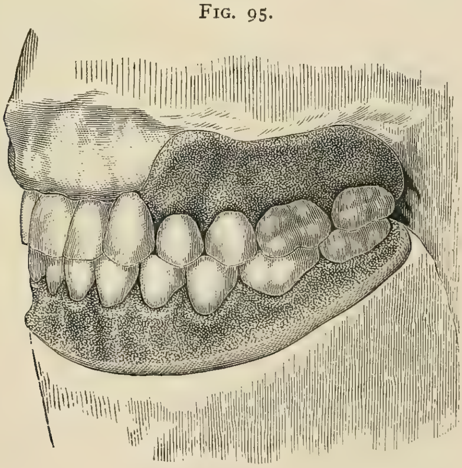
It is possible often, when teeth have been selected conforming as nearly as practicable to the requirements of the case in color, so to change the form of the teeth by judicious grinding of the proximate surfaces, cutting edges of the incisors, and the points

FIG. 94.



of the cuspids, and occluding surfaces of bicuspids and molars, as greatly to change the effect in the mouth, giving them an harmonious expression impossible in the use of manufactured teeth in their unchanged form. Figs. 92 and 93 indicate the treatment. This is particularly observable when they are ground in imitation

FIG. 95.



of the partial destruction of the occluding surfaces by erosion, a condition very commonly associated with middle age. The effect is still further enhanced by coloring the portions of the ground surfaces in imitation of the dark discoloration usually

associated with exposed dentine. This may be readily done in the manner described in the chapter on partial dentures mounted on metallic plate-base. The same process of coloring may also be applied to single porcelain teeth representing absorption or recession of the gum at the cervix, which is always of a darker hue than the crown (see Fig. 93). An additional device, sometimes employed to disguise the fact of artificiality, is that of introducing gold fillings into one or more of the front teeth. Cavities for this purpose are sometimes formed in porcelain teeth at the time of baking. When these are not readily procured, the operator may easily improvise them. A dovetailed slot may be ground in the proximate side of a front tooth with suitably formed corundum-discs, or a concave depression made and retaining pits formed with a hard-tempered steel drill. A correspondent of the *Cosmos* gives the following method of using the drill: "Use a hard-tempered, spear-pointed steel drill in the engine, and while operating keep wet with a solution of spirits of camphor and spirits of turpentine in equal parts. The cutting will be facilitated by giving the hand-piece a slight rotary motion. If a contour filling is desired, grind off with the corundum-wheel as much as is desired for 'contour,' after which make the retaining portion with the drill." Cavities, however, can be formed with greater facility by the use of the diamond drill.

With these general reflections concerning full dentures, we return to a consideration of the mechanical or manipulative processes concerned in the construction of an entire denture attached to a swaged metallic plate by soldering.

CHAPTER XX.

ENTIRE DENTURES ATTACHED TO A SWAGED METALLIC PLATE-BASE.

Method of Constructing an Entire Upper Denture Mounted on a Swaged Metallic Plate-Base.—The general form and dimensions of the required base to be used as a support for a complete denture for the upper jaw may first be indicated by drawn lines upon the plaster model, and a sheet-lead pattern obtained from this is to serve as a guide in securing the form of the plate to be swaged. The plate should be made sufficiently ample in its dimensions to cover all the hard palate, the alveolar ridge, and all portions of the external borders of the latter not directly encroached upon by the muscles and reflected portions of the mucous membrane of the lips and cheeks.

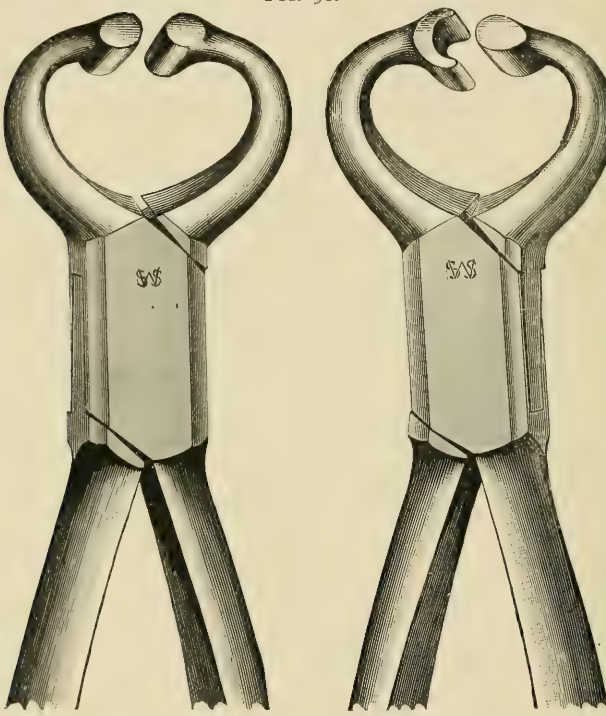
Before swaging, the plate should be well annealed, then its central portion is brought as nearly as possible to the form of the palatal face of the die with the No. 1 or partial counter-die (see page 169), forcing the heel of the plate down with suitable pliers and forceps in advance of the portion covering the more anterior concavity of the arch, preventing thereby a doubling of the posterior edge of the plate upon itself.

Having conformed the plate as nearly as practicable to the die, with the small counter and plate-forceps constructed for the purpose (Fig. 96), it should be placed between the die and the larger counters, which are forced together with a heavy hammer until a tolerably accurate coaptation of the plate is obtained, the latter being frequently annealed during the process of stamping to render it more pliable. At first considerable yielding and consequent deformity of the counter-die will occur; hence, after partial swaging, another should be substituted, and the process continued until the greatest possible accuracy of adaptation is secured. If the face of the die is marked by prominent and sharply defined rugæ, or other irregularities, such points will, to some extent, be bruised or flattened; it will therefore be expedient in such cases,

and better, perhaps, in all, to finish the swaging with a new and unused die and counter, in which case two or three moderate, steady, and well-directed blows of the hammer will be sufficient.

If the plate is brought into uniform contact with all parts of the face of the die, this conformity is the only reliable test of its adaptation out of the mouth. In no case will the swaged plate fit the plaster model perfectly, inasmuch as the unavoidable contraction

FIG. 96.



of the die, however slight, will, especially in deep-arched mouths, cause the plate to bind on the posterior and external borders of the ridge, preventing it from touching the floor of the palate; while the bruising, though inconsiderable, of the more prominent points upon the die, and a corresponding flattening of the plate at such points, will prevent uniform contact of the latter with the unchanged surface of the plaster model.

After final swaging, the plate should be again annealed with a heat nearly or quite equal to that which will be ultimately re-

quired in soldering. After this, any additional swaging should be avoided, unless the plate warps in the heat, which may be determined by applying it to the die. If any change has occurred, it should be reswaged, and again annealed at a high heat, and the operation should be repeated, if necessary, until the plate retains its integrity of form after the last annealing. This process of final heating does not apply to silver if in the form of a swaged plate, as this metal invariably suffers some change of form when subjected to an annealing heat.

Modifications in the Form of Plates for Entire Upper Dentures.—Whenever a central air-chamber is employed, it may be constructed in either of the ways described when treating of partial

FIG. 97.

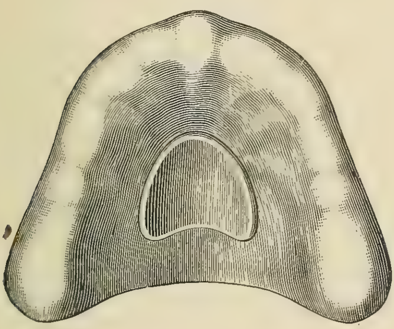
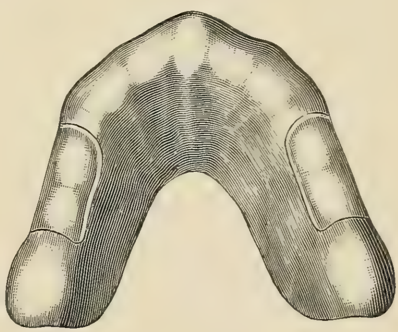


FIG. 98.



atmospheric-pressure plates. The general form of an entire upper denture with a central chamber is exhibited in Fig. 97. Other modifications in the form of cavity-plates for full upper sets are in limited use, as where chambers are arranged one on each side of the sloping walls of the palate, or directly over that portion of the ridge previously occupied by the anterior molar and the bicuspids on each side, as seen in Fig. 98, called "lateral cavity-plates." Whatever their general utility may be, cases doubtless occur where they may be advantageously employed; separately, as shown in the illustration, or in combination with the central chamber, as when any great inequality exists in the hardness of the ridge and palate, such as cannot be readily overcome by ordinary means. These lateral cavities or chambers are not cut out and soldered as is sometimes done with the central chambers. The cast, and consequently the die, is raised or built up slightly

at these points, which forms in the plate when swaged, the shallow cavities shown in the illustration.

Forming the Borders of the Plate.—In whatever way the plate is formed, a notch or fissure of sufficient depth to receive and permit an unobstructed play of the frenum of the lip should be formed in the front part of the plate, while the borders of the latter nearly opposite the anterior molars on each side should be narrowed to prevent undue contact of its edges with the folds of the mucous membrane stretching obliquely across from the cheeks to the ridge. Care should also be taken to trim away from the heel of the plate any portions that might otherwise encroach upon the soft palate.

It is only in the fewest number of cases that a rim can be swaged to form a groove or socket properly situated for the reception of the plate extremities of either single gum or block teeth, as it will usually be found impracticable to adjust the gum extremities to the socket thus formed without necessitating, in some degree, a departure from a just arrangement and antagonism of the teeth. Whenever it is thought best, therefore, to rim the plate, it will generally be necessary to adjust and solder a separate strip of plate or wire along the outer borders of the plate, covering somewhat the extreme edge of the gum, when gum-teeth are employed, and of the pink rubber-gum, when plain teeth are used.

Trying the Plate in the Mouth.—After the plate has been worked as nearly as possible into the required form, it should be applied to the mouth of the patient to ascertain the correctness of its adaptation to the parts before proceeding further with the operation. If the adaptation is found imperfect, the fault lies either in the impression or in undue contraction of the die. In the former case, another impression should be taken, and the plate reswaged; in the latter, a less contractile metal or compound should be employed in the formation of the die. To determine the practical efficiency of the adaptation and adherence of an atmospheric-pressure plate, various tests may be applied. The coaptation of its borders to the external walls of the ridge may be ascertained by inspection, and the patient's sense of contact or non-contact of its central portion with the floor of the palate may, in some degree, be relied on as evidence of the accuracy of

its adjustment to parts not visible. The tenacity with which the plate adheres on the application of direct traction cannot always be relied upon, inasmuch as a well-fitting plate will sometimes readily be dislodged in this manner, while, on the contrary, one but illy adapted to the parts may require considerable force to separate it from the jaw when acted on in the same way. *The most trustworthy test of actual or practical stability is firm pressure applied alternately over the ridge on each side and in front.* If the plate maintains its position and remains fixed under repeated trials of pressure applied in the manner indicated, the adaptation may be safely relied on; if it slides upon the palate or is easily disengaged from the mouth, the instability of the plate may be referred in many cases, not to a want of coaptation, but to a want of uniformity in the condition of the parts on which the plate rests. These conditions have already been sufficiently considered.

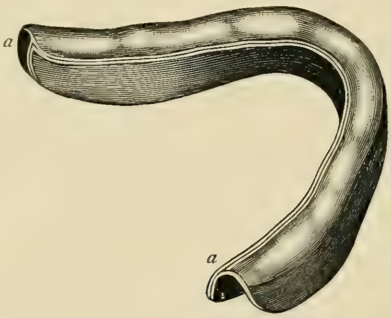
Method of Constructing an Entire Lower Denture Mounted on a Swaged Metallic Plate-base.—Aside from the differences in the form of the plate, and the manipulations incident thereto, the process of constructing a plate for the under jaw does not differ essentially from that already described in connection with full upper dentures.

If the lower plate is constructed from a single lamina of gold or other metal, *it should be somewhat thicker than that used in upper cases, and should also be of finer quality,* as the additional thickness of the plate and the peculiar form of the inferior maxilla render a greater degree of pliancy necessary in swaging it to the form of the ridge. The internal border of the plate should usually be doubled—either by turning the edge over in swaging, or by soldering on a narrow strip of plate or half-round wire as indicated at *a, a,* Fig. 99.

A more perfect adaptation of the plate to the ridge may be obtained by the use of a double instead of a single plate, in which case a thin plate, not exceeding No. 30 of the gage, should be swaged to the form of the ridge in the first instance, and then a duplicate plate, swaging the two together and uniting them to each other with solder. A plate of the specified thickness may be very readily and accurately conformed to any irregularities in the ridge, and when the two are united the base will be heavier and stronger than a single lamina of the ordinary thickness. Instead, however, of doubling the entire

plate, it will be sufficient, in most cases, to adapt the second plate only to the lingual surface of the first, extending it up from the lower edge to a point corresponding as nearly as possible with the inner portions of the base of the teeth when the latter are adjusted to the plate, that is, at about the point indicated at *a, a,* Fig. 99. A moderately thin plate may, in this manner, be used for the primary base, while the duplicate band will impart the requisite strength to the plate, and, at the same time, obviate the necessity of wiring its lingual border. In adopting either of the last-named methods, the plates, after they are united to each other, should be again swaged to correct any change of form incident to the use of solder.

Fig. 99.



Antagonizing Model for an Entire Upper and Lower Denture.—The following method is adopted in securing an antagonizing model for complete dentures:

Attach to the ridge of each plate a roll or strip of adhesive wax corresponding in width to the length of the teeth which will be required for each plate respectively; place the plates, with the wax attached, in the mouth, and trim away from the proximate edges of the wax until the two sections close upon each other uniformly throughout the circle; then cut away from the labial surfaces of the rims of wax, above and below, until the proper fulness and required contour of the parts associated with the lips and mouth are secured. The approximation of the two jaws, when the finished substitutes are ultimately adjusted to the mouth, will depend altogether upon the aggregate width given to the two sections of wax at this stage of the operation, and it is, therefore, important that the "bite" or closure of the jaws secured at this time should be such as will most

perfectly fulfil the requirements of the case in respect to the utility and comfort of the appliance, and the proper restoration of the normal facial expression.

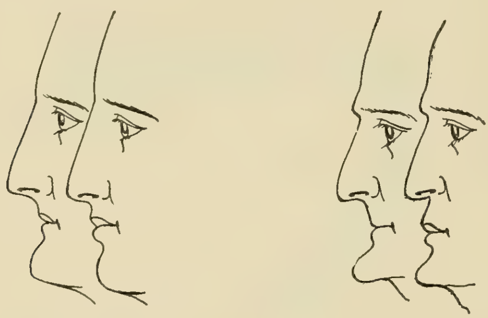
Re-posing the Features.—If there is any considerable change produced in the relation of the jaws habitual to them prior to the loss of the natural teeth, the characteristic expression of the individual will be very much changed or marred; an unnatural and restrained action will be imposed upon the muscles concerned in the movements of the lower jaw, which will render the use of the appliances, at least temporarily, if not permanently, uncomfortable and fatiguing, or even painful; while the utility of the fixtures may be impaired or wholly destroyed by compelling a particular application of forces in mastication inconsistent with their stability in the mouth. No specific directions, of course, can be given that will apply to all cases, but it may be observed that, ordinarily, the two sections of wax should be cut away from their approximating surfaces *until the jaws close sufficiently to permit the edges of the lips to rest easily and naturally upon each other when in a relaxed condition,* or the upper rim may extend somewhat below the margin of the upper lip, while the lower section of wax is cut away on a level with the lower lip, or a little below it. Cases occur, however, where a less exposure of the upper portion of wax, even though quite narrow, will be required; as where the alveolar ridge is very deep, and the lip covering it either absolutely or relatively short, or where the latter is retracted, exposing, even when in a state of repose, a greater portion of all of the crowns of the teeth, and in extreme cases the margins of the gum. Between the latter extreme and an inordinate extension of the upper lip below the ridge, all intermediate conditions occur, and the practitioner, aiming to produce an agreeable, harmonious, and truthful expression of all the parts, must rely wholly upon his judgment in reference to the necessary approximation of the jaws, the restoration of the natural fulness and contour of the face, and the relative length to be given to the upper and lower teeth.

The dentist needs to study the face of his patient as the artist studies his picture, for he displays his genius not upon canvas but upon the living features of the face. He should know the origin and insertion of the principal muscles of which the face is formed, and which ones he is to raise, otherwise he will be liable to produce distortion instead of restoration. This improvement consists of

prominences made upon the denture of such form and size as to bring out each muscle or sunken portion of the face to its original fulness; and when these are rightly formed, they are not detected by the closest observer (see Fig. 100). There are four points of the face (of many persons) which the mere insertion of the teeth does not restore, viz., one upon each side beneath the malar or cheek bone, and also a point upon each side of the base of the nose, in a line toward the front portion of the malar bone.

The extent of this falling-in varies in different persons, according to their temperaments. If the lymphatic temperament predominates, the change will be slight. If nervous or sanguine, it may be

Fig. 100.



very great. The muscles situated upon the sides of the face, and which rest upon the molar or back teeth, are the zygomaticus major, masseter, and buccinator. The loss of the upper teeth causes these muscles to fall in. The principal muscles which form the front portion of the face and lips are the zygomaticus minor, levator labii superioris alæque nasi, and orbicularis oris.

These rest upon the incisor, cuspid, and bicuspid teeth, which, when lost, allow the muscles to sink in, thereby changing the form and expression of the mouth.

The insertion of the front teeth will, in a great measure, bring out the lips, but there are two muscles in the front portion of the face which cannot, in many cases, be thus restored to their original position; one is the zygomaticus minor, which arises from the front part of the malar bone, and is inserted into the upper lip above the angle of the mouth; the other is the levator muscle, which arises from the nasal process and from the edge of the orbit above the in-

fraorbital foramen. It is inserted into the ala nasi, or wing of the nose and upper lip.

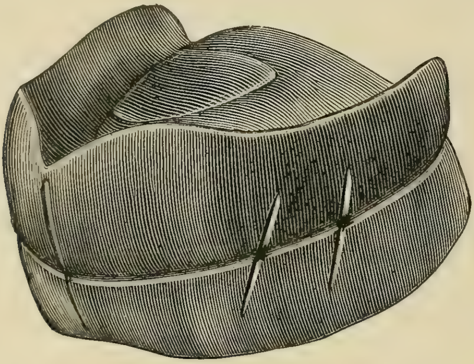
The prominences before mentioned, applied to these four points of the face, beneath the muscles just described, bring out that narrowness and sunken expression about the upper lip and cheeks to the same breadth and fulness which they formerly displayed. If skill and judgment have been exercised in building up and forming the wax bite-pieces and is continued throughout the operation, the result will be highly pleasing and of practical utility.

Projection of the Lower Jaw.—Patients, when requested to close the mouth *naturally,* are very liable to *project* the lower jaw; hence it is well to have them open and close the jaws several times, observing at the same time if the separate portions of wax meet in precisely the same manner at each occlusion. If the bite varies at every approximation of the jaws, directions should then be given to relax and abandon for the moment all control over the muscles of the lower jaw; the patient should then be directed to close lightly upon the wax in *the back part of the mouth.* The attention thus being drawn in that direction, the jaw will naturally come back and close in the normal position. The median line should then be drawn across both plates, and a cross, or two or three oblique lines made on each side; after this is accomplished, the patient should again be directed to open and close the mouth, and note whether these lines are brought accurately together; if so, it is fair to assume that the bite is correct. We should then have the patient bring slight pressure upon them by closing the jaws a little harder, when, if the occluding surfaces have been previously passed over the flame, they will adhere so firmly that they may be readily removed from the mouth together, without displacement. Or a heated knife-blade may be passed between the two sections, the melted wax temporarily uniting them. Another very convenient and secure method is to attach them together by means of two strips of metal bent in the form of a staple; these may be warmed in a spirit-flame, and pressed into the wax, one on each side—one end penetrating the upper rim of wax, the other the lower.

The plates, *attached to each other* as shown in Fig. 101, may be removed from the mouth, plaster mixed and poured into them to form temporary models for attachment in the articulator. When the plaster is sufficiently condensed, the line across the wax in front

should be extended in a direct line across the borders of the plaster model above and below, as, in arranging the teeth, the wax will be

FIG. 101.



removed, and without this precaution the mesial point of the mouth may be lost.

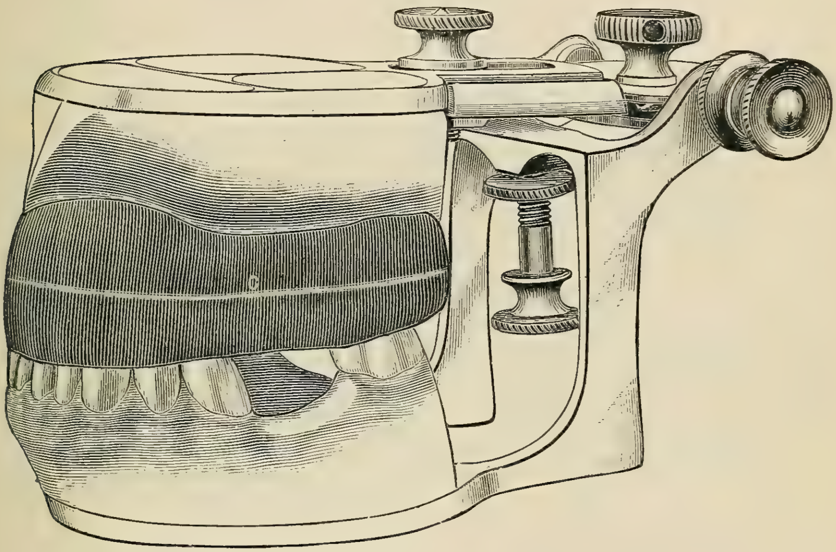
Antagonizing Model for an Entire Upper Denture with the Natural Teeth of the Lower Jaw Remaining.—In forming an antagonizing model to be used as a guide in arranging and articulating a full upper denture where all or a part of the natural organs of the inferior jaw are remaining, a rim of wax should first be adjusted to the borders of the plate, one or two lines wider than the required length of the artificial teeth. When placed in the mouth, the exterior surface of the wax draft should be cut away or added to, until the proper fullness of the parts is restored. The patient should then close the lower teeth against the wax, *imbedding them just sufficiently to indicate the cutting edges and grinding surfaces.* The median line of the mouth is then indicated upon the wax and the plate removed, when the two casts (the lower having been previously secured from a wax or modeling compound impression) should be secured in the articulator as illustrated in Fig. 102.

Articulators.—Various articulators have been devised. Fig. 103 illustrates one of the simpler forms, while a very ingenious and novel device has been brought to the notice of the profession by Dr. W. G. A. Bonwill, to which we give considerable space. The inventor has characterized it as the "*Anatomical Articulator,*" and describes it as follows:

" It is modeled on the same geometrical system as the human jaw.

" I found by measurement that the average width of the lower jaw from center to center of each condyle was four inches, and from the same center of each condyloid process to the median line of the lower jaw, where the cutting edges of the lower incisors meet, was also four inches, making of the human jaw an equilateral triangle. This holds good in all jaws, and the difference of ¼ of an inch in this

FIG. 102.



radius of a circle of four inches would make but little practical difference as to the results.

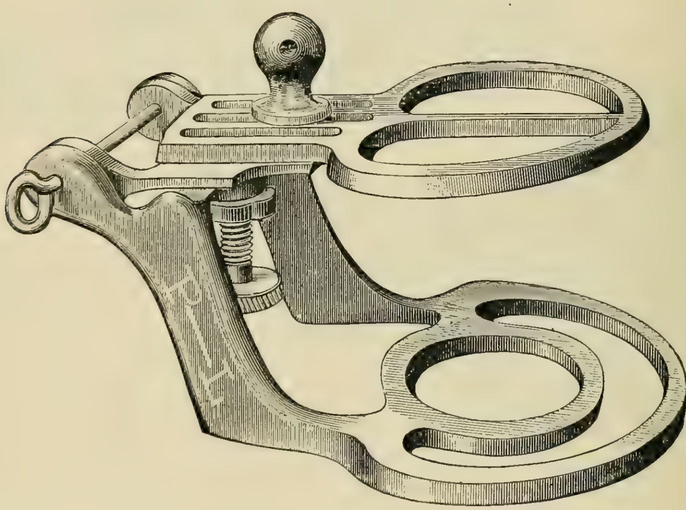
" This beautiful law enables us to have the fullest benefit of mastication at the least expense of power and motion in the arc of the circle of four inches as a radius.

" This being an absolute law, I have so made this articulator, and the cast of every case is set therein with the median line at the lower centrals just four inches, by the dividers, from each condyloid process. If an unusually large jaw, then the cast is put a very little distance further out.

" For all full sets, the articulation is so perfect, as made in this, in the laboratory, as to need but a trifling touch in fitting in the mouth.

"I found that there is a further positive law in the mechanism of the human jaw that should be regarded in every substitute made therefor, and that is, just in proportion to the depth of overbite of the centrals, there is a curvature from the mesial surface of the first molars back, through the other molars, up the ramus. That this curvature upward and backward at the ramus is due solely to the depth of closure of the upper over the lower jaw. That where there is occlusion or closing of the cutting surfaces of the incisors directly

FIG. 103.



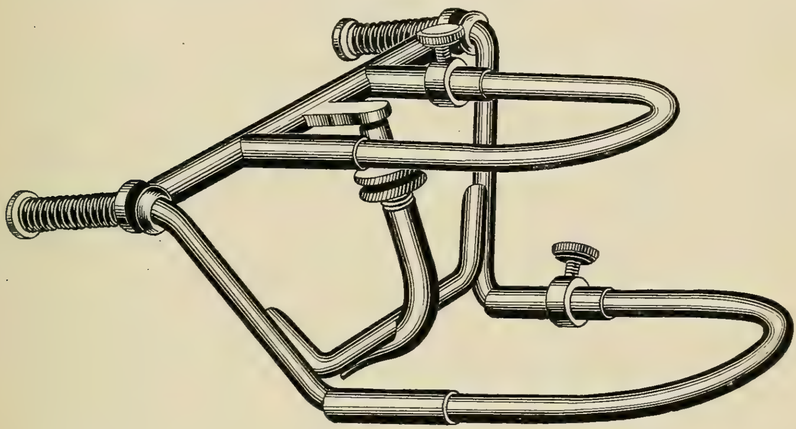
upon each other, then a straight line, directly backward, is the consequence. If curved at the ramus, in such a case no lateral or forward movement of the lower jaw could occur—only the up and down.

"When there is ⅛ of an inch depth of bite, then, as you go back to the center of motion—the condyloid processes—the cusps in the bicuspids and molars grow less deep, and the curvature at the ramus is ⅛ of an inch out of line.

"When there is an overbite of ⅛ of an inch, then, in opening the lower jaw and carrying it forward to use the incisors for cutting, the back teeth of the lower jaw are brought forward; and as the second molar is higher out of line than the first molar, it comes in contact with the distal surface of the first superior molar, which begins just here to curve upward, and is the highest out of line in

the superior jaw, and they meet at the same time that the incisors do. And the same law holds good when the lower jaw is turned to the right or left; the molars are brought in contact to equalize the force which would be brought upon the incisors only. Besides, the recognizing of this law enables the cusps or palatal and lingual sides of the molars of both jaws to be utilized in every position the lower jaw may take in mastication. Upon this plan I make all my artificial dentures, most of their articulating surfaces being utilized at every position of the lower jaw. Any human jaw will show this

FIG. 104.



system, which, by this system, can be made just as complete, and more so in many cases, than the normal, or such as is found in advanced civilization.

"When a set of teeth is commenced in this articulator with the upper overbiting the lower ⅛ of an inch, as you set each tooth backward toward the condyloid processes they will assume the exact angle and depth of cusps, as well as the curvature at the ramus, as found in nature. If both jaws are in direct opposition at the incisors, then all of the teeth must of necessity be on a perfect plane, or but one would touch when in lateral position.

"With this one base, which Fig. 104 shows, there is a separate bow to each part of base, one for upper and one for lower jaw, which can be removed as soon as the plaster in one case is allowed to harden on the rim. This can be marked and laid away for a year if neces-

sary, and then articulated. A pair of bows can be used for as many separate cases, while only one base is required, which should be made absolutely and geometrically exact—approximately so.

"The set screw in the center is to hold the jaw or casts apart after the proper distance has been secured in taking the bite. Or this may be regulated on the bite in wax, which, before it is taken off the base-plate, has the exact height marked by a pair of dividers on the plaster at the median line, measuring from the cutting edge of wax, and then, when the first central or block is set, there is no longer any call for a prop to keep open the jaws of the articulator. When this height is taken with the dividers, it is marked on the top of each cast for future reference. The dividers make each cast exact without a scale for measurement.

"Articulate the upper set first, and retain on the lower base the wax for length and fulness. When the upper are all on, then the lower incisors are gaged as to the height or length by the dividers while the wax is still on the base-plate and taken from the height marked on the lower cast for reference.

"Make the lateral movement as soon as the first tooth or block is in position where the case is an upper one with a good lower jaw of natural teeth.

"When a full set, the upper are first ground on and shaped so as to meet the intended overbite, and when the lower set are ground on, the upper can be changed to suit the lower, so as to allow the whole of every cusp to touch at nearly every lateral movement of jaw.

"When the plaster case is to be set in the articulator, it must be done with the dividers set just four inches, with one point at the median line as formed by the lower incisors, and the other carried over to each condyloid process as marked on the articulator. This makes the center of jaw equidistant from the condyles. The study of this principle will make one fully realize the beautiful workings of Divinity, which is only governed by positive law in every department of the universe. With this plan understood, one will never again attempt to articulate a set of teeth on the unwritten law, as now universally made and recognized by every dentist in the land.

"Until this system is taught in the schools and by private practitioners, no truly artistic and fully natural set of teeth can ever be made, for we have been without law in this department. To describe it is not enough. It must be seen and demonstrated, one

tooth at a time, until the whole set is made. Only in this way can it be understood.

"The construction of this articulator is very simple. It is made of brass wire (1/8 of an inch in diameter), and brass tubing to allow the size of wire to fit closely, and move freely therein when drawn out or pushed up. The spiral spring on either condyle allows of easy lateral motion to the lower part, and from exactly the same standpoint as in nature; that is, one of the lower condyles moves forward in the glenoid cavity while the other remains still. Every part of it is rigid except the movement at the condyles, and the joints or bows are only temporarily so. There is also an up-and-down motion made at the condyles by raising the bow up or down.

"No case, when once fixed in it, can become disarranged. If the bite in the wax is not correct, *no articulator can make it so.* You must go back again to the mouth and retake it, which is easily done at first by asking the patient to swallow, when the jaws will automatically close and assume their normal position. If now correct, there is never any necessity for a screw to change it when once in this articulator.

"There can be no excuse for failure or inartistic work when this instrument is once understood and the law controlling the human jaw. As we may forever have to resort to artificial dentures, we should demand of the colleges that such an instrument be used, and it alone, as furnishing the only hope now offered of an approach to high-toned, artistic, mechanical dentistry. Until we can be taught to appreciate that law is the governor of the universe, and applicable in every branch of dentistry, we are false men, and will set 'false teeth,' and never realize our high destiny."

Grinding and Adjusting Single Gum Teeth.—In *arranging* or adjusting single gum teeth to the plate in those cases where the changes in the form of the alveolar ridge, consequent on absorption, are completed, the portions applied to the base should be ground away sufficiently to restore the required fulness of the parts and to give proper length and inclination to the teeth. The coaptation of the ground surfaces to the base should be accurate enough to exclude perfectly particles of food, and to furnish such a basis to each tooth as will provide most effectually against fracture when acted upon by the forces applied to them in the mouth. The gum extremities of the teeth should also be accurately united to each other laterally by

grinding carefully from their proximate edges until the joints or seams will be rendered incapable of ready detection in the mouth, care being taken that this coaptation of the adjoining surfaces is uniform, for if confined to the outer edge alone, portions of the gum enamel may be broken away in the process of soldering.

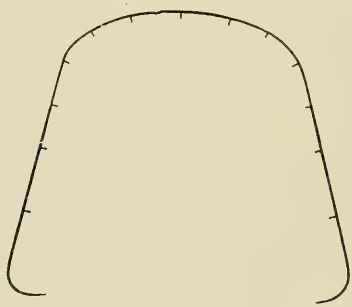
Arranging for Temporary Plates.—In the construction of substitutes designed to fulfil only a temporary purpose, and where the alveolar processes remain in a great measure unabsorbed, and plain teeth (those representing but the crowns of the natural organs) are used, but little skill will ordinarily be required in adjusting and fitting them to the base. If the ridge in front is prominent and but inadequately concealed by the lip, as where the teeth have been but recently extracted, all those portions of the border of the plate in front, anterior to the first or second bicuspid on each side, may be cut away on a line a little within the required circle of the anterior teeth and scalloped, permitting the anterior cervical portions of the artificial incisors and cuspids, and, in some cases, the anterior bicuspids, to overlap the edge of the plate and rest directly and firmly upon the gum in front. This abridgment of the plate is shown in Figs. 94, 95, page 231, and will not, ordinarily, materially affect the adhesion or stability of the substitute.

There are cases of a mixed character that render it more difficult to effect a harmonious and symmetrical arrangement of the teeth, as where a limited number of the natural teeth at intervals have been long absent, and the excavations in the ridge consequent on absorption alternate with other points upon the ridge in a comparatively unchanged condition. To give uniformity to the denture by restoring perfectly the required circle of the arch in such cases will necessitate the employment of plain and single gum teeth conjointly. Whenever necessary, those portions of the base occupied by the plate teeth may be cut away in such a manner as to permit the latter to be adjusted directly to the unabsorbed gum as before described.

Arranging the Teeth for a Full Upper and Lower Denture.—In the process of grinding the teeth to the base, above and below, the operator should commence by first arranging the superior central incisors, and then the lower, and so, passing back from tooth to tooth, grind and adjust an upper and lower tooth alternately, keeping the upper ones in advance of those of the lower jaw. The central incisors above should be placed parallel with each other, but the

cutting edges of the laterals and the points of the cuspids should incline slightly toward the median line of the mouth. In arranging the teeth of the upper jaw, the anterior six may be made to describe, with more or less exactness, the segment of a circle, but a somewhat abrupt angle may be given to the arch on each side by placing the first bicuspid within the circle in such a way that, when standing directly in front of the patient and looking into the mouth, only a narrow line of the exterior face of the crowns of these teeth will be seen, while the remaining teeth posterior to them should be arranged nearly on a straight line, diverging as they pass backward. When arranged in the manner described, the peripheral outline of the arch will exhibit somewhat the form presented in the diagram (Fig. 105).

Fig. 105.



In regard to the practical efficiency of an upper denture retained in the mouth by atmospheric pressure or adhesion, it is important that the teeth engaged in the comminution of food, as the bicuspids and molars, should occupy a position directly over the central line of the ridge, and should either be arranged vertically or with a slight inclination toward the center of the mouth. The liability to displacement of the substitute in mastication will thus be greatly diminished, whereas, if placed outside of the line indicated, and especially with a diverging inclination, the stability of the appliance will be endangered and the functions of mastication impeded, notwithstanding other conditions necessary to complete success have been fully secured. In arranging the upper and posterior teeth as described, it will sometimes be necessary to give to the opposing under teeth a decided inward inclination in order to effect a satisfactory antagonism of the teeth; and cases occur where a practical articulation cannot be secured without departing in some degree from the arrangement of the upper teeth spoken of,—as where a great disparity exists between the posterior transverse diameters of the two jaws, a medium-sized, or even small arch above being associated with an expanded ridge below.

In articulating the upper and lower teeth, the normal occlusion of the natural organs should be imitated as nearly as the other essential requirements of the case will admit. Hence the upper front teeth, describing the segment of a larger circle than the corresponding teeth of the lower jaw, will project beyond and overlap slightly the cutting edges of the latter; and having a greater width of crown, they will extend latterly beyond the opposing teeth, covering one-third of the crowns of those next adjoining, so that when the cuspids of the upper jaw are reached, they will close between the lower cuspids and first bicuspids; and, passing back, the anterior superior bicuspids between the first and second bicuspids below; the posterior bicuspids above, between the second inferior bicuspids and anterior molars; the first superior molars between the first and second molars below; while the anterior half of the posterior molars above will close upon the posterior half of the inferior second molars, the remaining posterior half of the second molars above extending posteriorly beyond those of the lower jaw. The outer cusps of the superior bicuspids and molars will overlap those of the inferior teeth; while the inner cusps of the teeth of the superior jaw will pass into the depressions in the lower teeth formed by the internal and external cusps, and the external cusps of the inferior teeth will, in like manner, be received into the corresponding excavations of the upper teeth. An abnormal relation of the jaws, as where undue projection, absolutely or relatively, of either maxilla exists, or where the lower jaw closes on one side or other of the upper, will frequently compel a departure from the ordinary arrangement of the artificial organs, the extent of which must be determined by the necessities of each individual case.

In selecting teeth for a full upper denture in those cases where natural organs are remaining below, or *vice versa,* the color, size, and form of the latter will serve as a guide in the choice of teeth appropriate for the opposite jaw. In fitting and arranging the teeth upon the base, and in antagonizing them with the opposing natural teeth, the same general principles apply as those already adverted to in connection with full upper and lower dentures.

Having adjusted the teeth to the base, they should be placed in the mouth before uniting them permanently to the plate, to detect and remedy any error of arrangement either in respect to prominence, position, inclination, length, or antagonism.

Forming a Rim to the Plate.—If the case is one where single gum or block teeth are employed, and it is intended to form a socket or groove upon the borders of the plate for the reception of the plate extremities of the teeth, the rim forming the groove should be fitted and soldered to the base before investing the piece in plaster. *If the alveolar ridge above is shallow, and but imperfectly concealed by the lip, a rim to the plate will be inadmissible,* as when the mouth is opened and the lip retracted, as in laughing, the metallic band will be exposed to view. A rim may be fitted and attached to the base in either of the following ways:

1. A strip of plate from one to two lines in width is adjusted to the plate, with one edge resting on the uncovered border of the plate, close to the gum extremities of the teeth, and the other overlapping and embracing the latter. The rim may be more conveniently adjusted by employing two pieces, extending from each heel of the plate and uniting in front.

2. A half-round wire with the edge beveled where it joins the ends of the teeth, forming a narrow groove, may, in like manner, be fitted to the plate, furnishing a shallow bed for the gum extremities of the teeth. Or a narrow strip of plate, about the thickness of heavy clasp material, may be substituted for the half-round wire. In either case, the better plan is first to trace the outlines of the gum portions of the teeth upon the plate with a sharp instrument; remove the wax and teeth from the plate; draw another line a little within the first all round, and solder the rim to the line last drawn; remove the teeth from the wax, and readjust the latter in its proper place upon the plate; then fit each tooth separately to the rim by grinding away sufficiently from the end of the tooth to effect an accurate adjustment of it to the socket. The ends of the teeth may be ground away to the rim until the platinum pins freely reënter the rivet-holes in the wax, thus restoring them to their proper position in relation to the base.

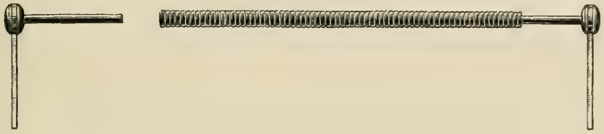
3. Another method of forming a rim consists in swaging a strip of plate accurately to the form of the parts to which it is applied. An impression in wax or plaster is first taken of the gum surfaces of the teeth and exposed border of the plate; but as it will be impossible to detach either wax or plaster in perfect condition when encircling the entire arch, or to swage perfectly with a die so unfavorably formed for stamping, separate impressions of the two lateral

halves of the piece should be taken from these plaster models, and from the latter, dies and counters produced;—with these, two strips of plate of sufficient width are swaged, each extending from the heel of the plate to a little beyond the median line in front, overlapping slightly at the latter point. The portions of the swaged strips embracing the plate ends of the teeth are then trimmed to the proper width, and scalloped, if desired, in correspondence with the festoons of the artificial gums. In whatever way the rim is formed, when it has been fitted to the plate and teeth it may be held temporarily in place with clamps (such as are shown in soldering air-chamber in plate, page 201) adjusted at two or three points around the plate and then transferred to a piece of charcoal, or soldering block, and secured by first tacking it at two or three points with solder. The groove may then be filled with whiting, mixed with water or alcohol to prevent the solder from flowing in and filling it up; after which small pieces of solder are placed along the line of union next the edge of the plate, and the rim permanently united throughout with the blowpipe; after which the wax and teeth are reapplied to the plate.

Constructing and Attaching Spiral Springs.—The success which has been attained in the use of atmospheric pressure and adhesive plates has almost entirely superseded the necessity of employing spiral springs as means of support; nor should the latter be resorted to except under circumstances that preclude the use of the former, as in case of cleft palate, for instance. When applied, they should be attached to the base on each side between the posterior bicuspid and first molar below, and opposite the posterior bicuspid above. To the border of the plate near the base of the teeth a narrow strip of plate is soldered, extending up and lying closely against the side of the latter, to the end of which, near the grinding surfaces of the teeth, is adjusted a small, circular cap of gold connected with the standard by a small wire on which the looped extremity of the spring plays. To each end of the spring is attached a gold swivel, one end to enter the hollow in the wire, the other attached to the plate, either by soldering or vulcanizing as the case may be. The appliance is shown in Fig. 106. Figs. 107 and 108 exhibit the application of springs to an upper and lower denture. In this instance plain teeth with rubber attachment are shown, but they may be readily attached to any form of teeth or plate.

Investing.—The plate, with the wax and teeth in place, is next incased in a mixture of plaster, preparatory to backing the teeth and uniting them with solder to the base. For this purpose plaster and sand may be employed, using as little of the former as will serve

FIG. 106.



to hold the investment together during the subsequent manipulations. Asbestos may be added, and is a useful ingredient. Burnt plaster, or that which has been previously used for investing, may be substituted for the sand and asbestos, adding a sufficient quantity

FIG. 108.

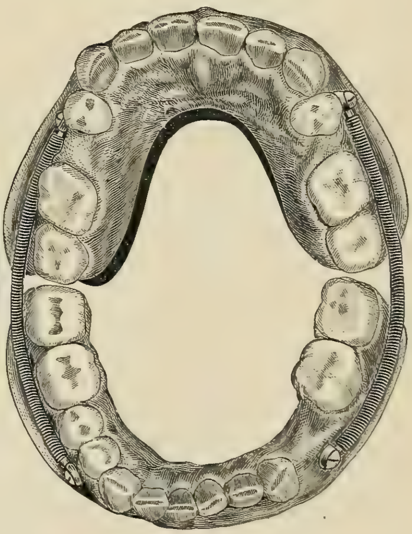


FIG. 107.

of unused plaster to effect consolidation. Either of the combinations mentioned will suffer but little change in the fire if properly managed. It is customary to incase the piece in the plaster mixture to the depth of from ½ to ¾ of an inch, leaving only the lingual surfaces of the plate and teeth uncovered.

Warping or Springing.—However comparatively free from change of form the best combinations of plaster may be, yet some slight contraction of the body of the investment doubtless ensues on the application of heat, and it is probable that so large and resistant a mass must tend, in some degree, to produce deformity of the plate in soldering; for, as the investment contracts and the plate at the same time expands when heated, a change in the form of the latter must occur whenever the force exerted by the shrinking plaster exceeds the expansive force of the metal; and when the peculiar form of the upper plate is considered, we can readily conceive how a slight contraction of the plaster of the thickness mentioned may "warp" or "spring" the plate when its uniform linear expansion and contraction is so effectively opposed. The change in the form of the base from this cause will, according to the writer's observations, be found, in an upper plate, to exist on each side of the sloping walls of the palate, embracing the posterior half or two-thirds of the plate at these two points—the change manifesting itself in an inward displacement of the lateral walls of the plate midway between the summit of the palatal arch and the most depending portion of the ridge. We would suggest in explanation of this result that, as the plaster contracts with sufficient force to carry the plate with it, the sides of the latter are approximated, while the palatal portion is at the same time lifted up. Now it seems plain, that inasmuch as the portions of plate overlapping the ridge are incased in and embraced by the plaster, and as the palatal portion is arched in form with its convexity presenting to the plaster, and therefore self-sustaining in respect to its own peculiar form, the special configuration of these parts cannot suffer any appreciable change; but as they are forced toward the common center of the mass, their *relation* to each other is also changed, and this changed relation must necessarily result in a deformity of those parts of the plate which offer the least resistance to the contractile force of the plaster. In obedience to this necessity, the sides of the plate along the sloping walls of the palate, which from their form are neither resistant nor self-sustaining under pressure, and whose inward displacement is unopposed by any counterforce, are projected in toward the center of the palatal excavation in proportion as the borders and central portions are approximated or converged in the direction of the center of the piece. The practical effect of this approximation of the lateral and posterior borders

and internal displacement of the plate is to make the latter "bind" upon the outer and posterior borders of the alveolar ridge, and to throw the central portion of the plate from the roof of the mouth.

Methods of Overcoming the Tendency to Change in Form.— To obviate, as far as practicable, any change in the form of the plate which may result from the contraction of the plaster investment, various expedients have been suggested, but the following will sufficiently counteract the influence of the plaster by permitting an unobstructed expansion and contraction of the metallic base. Take a band of tolerably thick copper plate, as wide as the plate and teeth are deep; bend it to the form of the plate, but large enough to leave a space of nearly ½ of an inch between it and the teeth, the ends being united to each other back of the plate by riveting or otherwise. Holes are then made in the band at numerous points throughout its extent, through which wire is introduced and interlaced on the inside in such a way as to form loops, the latter extending in to within a short distance of the teeth. The plaster is then filled into the space between the band and teeth, even with the cutting and grinding surfaces of the latter; the palatal surface of the plate is also covered with plaster and may be connected with the outer portion by a very thin layer at the edge of the plate, or the two may be entirely disconnected. The expansion of copper being very nearly that of gold, the body of the plaster, when heat is applied, will be carried in advance of the borders of the plate as the latter expands, while the thin portion of plaster at the edges of the plate will allow the central portion of the latter to expand with but little or no interruption. On cooling, the entire mass will contract and assume its original form, unless warping is induced by other agencies acting independently of the enveloping plaster, as excess or unequal distribution of solder, irregular heating, etc.

It is not, ordinarily, necessary to provide by any special expedient against warping of the lower plate, as any slight change of form consequent on contraction will not materially affect its adaptation to the lower jaw—its only effect being to impart to the substitute a slight lateral play upon the ridge. The plaster on the inside of the lower piece may be cut away to the edge of the plate, while that external to the teeth should not be added in greater quantities than is barely sufficient to hold the latter in place while backing and soldering them to the base.

Backing or Lining the Teeth.—The plate being properly invested, all portions of the wax attached to the inner surface of the teeth and plate should be thoroughly removed with suitable instruments, after which stays or backings are to be adjusted to the teeth. In reference to the method of forming and adjusting backings, little need be added to what has already been said when treating of partial dentures. One method, not there specified, consists in first fitting to each tooth separately, in the usual manner, a thin backing formed of platinum, which is temporarily fastened to the tooth by splitting and spreading apart the ends of the rivets with a small chisel-shaped instrument. The teeth are then removed from the investment and partially imbedded side by side in plaster, the platinum strips remaining uncovered. The plaster and teeth may then be raised to a full red heat with a blowpipe or by placing them in the furnace. Small pieces of gold plate, of equal fineness with the base, are then placed upon the surfaces of the platinum backings and thoroughly fused with the blowpipe until they flow perfectly in around the rivets, and uniformly over the surface. If sufficient heat is applied, the solder will insinuate itself between the stay and tooth, and thus render the coaptation of the two perfect. Small pieces of gold plate should be added until sufficient thickness is imparted. The backings are then trimmed smoothly, when they may be placed back in the investment in their appropriate places. They may then be united to each other laterally in sections or continuously, when the teeth are joined to each other throughout, a very small quantity of solder being sufficient to support them, provided it is well diffused along the joints, uniting them perfectly at all points.

Soldering and Finishing.—The process of preparatory heating, soldering, pickling, and finishing the plate is the same in all respects as that described when treating of partial pieces (see p. 210), and need not, therefore, be recapitulated.

In the final adjustment of the finished piece to the mouth, and after any additional grinding of the masticating surfaces of the teeth necessary to perfect the antagonism has been performed, such instructions should be given to the patient in regard to the care and management of the appliances as will best promote their immediate and successful use. The wearer should be impressed with the absolute necessity of early and prompt attention to any injuries inflicted upon the soft tissues of the mouth by the substitutes, as much future

trouble and annoyance, if not permanent mutilation of the parts, may result from neglect, but which may be readily averted, in most instances, by a timely removal of the sources of injury. To obviate, in some measure, the tendency to displacement of the base which usually accompanies the first use of artificial teeth, and especially the upper denture, the patient may be directed, when dividing food with the front teeth, to press the substance backward and upward against the cutting edges of the superior incisors at the same time that the opposing teeth are closed upon each other, thus dividing completely the substance seized. In reference to the mastication of food, it has been suggested to instruct the patient to distribute, by the action of the tongue, the portions of food as equally as possible on each side of the mouth, in this manner distributing the forces applied, and thereby lessening the chances of lateral displacement of the substitute.

CHAPTER XXI.

MANUFACTURE OF PORCELAIN TEETH.

The perfection and completeness of results attained at this day in the production of porcelain teeth, approximating so nearly the natural organs in all their more obvious, physical, and distinctive characteristics as to be almost, if not quite, indistinguishable from the latter when applied in obedience to the esthetic requirements of individual cases, is one of the marvels of ceramic art. Nowhere, perhaps, have the conceptions of genius been embodied in porcelain with more truthfulness or greater fidelity to nature than in the exquisite and wonderful imitations of the dental manufacturing laboratory.

So amply and satisfactorily has the intelligent, progressive, and well-directed enterprise of manufacturers provided for all the ordinary needs of prosthetic practice in the almost endless variety in size, color, configuration, relation, and adaptability of single and sectional teeth, that the work of hand-carving is now rarely demanded of the general practitioner, except in extreme cases resulting either from accident or disease. Thus, as aptly remarked by the late Professor Austen: "The dental depot not only renders service by the superior excellence of the surgical instruments and prosthetic materials which it supplies, but it directly benefits the science and art of dentistry by releasing the practitioner from manufacturing toil, and giving time for the acquirement of increased knowledge and skill. Thus, if the time heretofore given to block-making were devoted to the study of dental esthetics, patients would have the benefit of an artistic selection from a far larger variety of porcelain dentures than could otherwise possibly be made."

As affording some curious as well as practical information in regard to the composition and manufacture of porcelain teeth, the following descriptions will be found of interest:

Components of Dental Porcelain.—Manufactured single and sectional mineral teeth, carved block-teeth, continuous-gum mate-

rial, etc., are composed of two distinct portions—the *body,* or *base,* and *enamel.* The chief mineral substances which compose the body are *silex, feldspar,* and *kaolin.* The enamel, both crown and gum, consists principally of *feldspar.*

The various tints or shades are imparted to the porcelain by certain metals in a state of minute division, or their oxids. The more general properties of the mineral ingredients will be first described.

Silex.—Silex, silica, or silicic acid, is a white powder, inodorous and insipid. It forms the chief part of many familiar mineral formations, as quartz, rock-crystal, flint, agate, and most sands and sandstones, in some of which it occurs nearly pure. Silica, in its pure state, is insoluble in water or acids, and is infusible in the highest heat of the furnace; it melts, however, in the flame of the oxyhydrogen blowpipe, passing into a transparent, colorless glass. Its specific gravity is 2.66; and it is composed of silicon, 48.04, and oxygen, 51.96. Only the purest varieties of silex are employed in the manufacture of porcelain teeth. It is prepared for use by subjecting it to a white heat and then plunging it into cold water, after which it is ground to a very fine powder in a mortar.

Feldspar.—This mineral substance occurs crystallized in oblique rhomboidal prisms, and is a constant ingredient of granite, trachyte, porphyry, and many of the volcanic rocks. The feldspathic mineral formations present either a pearly or vitreous luster, and vary in color, being red, green, gray, yellow, brown, flesh-colored, pure white, milky, transparent, or translucent. Feldspar yields no water when calcined, melts at the blowpipe into a white enamel, and is unaffected by acids. It is composed, according to Rose, of silica, 66.75; alumina, 17.50; potash, 12; lime, 125; oxid of iron, 0.75. It is found in various localities throughout the United States, the purest and whitest kinds being employed in the manufacture of mineral teeth. It is prepared for use in the same manner as silex.

Feldspar, from its ready fusibility, serves to agglutinate the particles of the more refractory ingredients, silex and kaolin; and when diffused throughout the mass imparts to the porcelain a semi-translucent appearance.

Kaolin.—Kaolin, or *decomposed feldspar,* is a fine white variety of clay, and is composed chiefly of silica and alumina, the latter being the characteristic ingredient of common clay. It is found in

various localities throughout the Eastern States and in parts of Asia and Europe. Kaolin is refractory, or fire-proof, but is rendered more or less fusible by the contaminations of iron and lime with which it is usually combined. The opaque and lifeless appearance characteristic of the earlier manufacture of mineral teeth was due to the introduction of a relatively large proportion of this clay into the body of the porcelain. The peculiar translucent and lifelike expression which distinguishes the beautiful imitations of the present day is due, in great part, to the comparatively small proportion of kaolin clay, and an increased amount of the more fusible and vitreous component, feldspar.

Kaolin is prepared for use by washing it in clean water; the coarser particles having settled to the bottom, the water holding the finer ones in solution is poured off, and when the suspended clay is deposited at the bottom of the vessel, the water is again poured off, and the remaining kaolin dried in the sun.

Coloring Materials.—The following metals and oxids are employed in coloring mineral teeth: titanium, platina sponge, and oxid of gold being those chiefly used in producing the more positive tints, by combining which, in varying proportions, any desired shade or color may be obtained:

METALS AND OXIDS.	COLORS PRODUCED.
Gold in a state of minute division,	Rose red.
Oxid of gold,	Bright rose red.
Platina sponge,	Grayish-blue.
Oxid of titanium,	Bright yellow.
Purple of Cassius,	Rose purple.
Oxid of uranium,	Greenish-yellow.
Oxid of manganese,	Purple.
Oxid of cobalt,	Bright blue.
Oxid of silver,	Lemon yellow.
Oxid of zinc,	Lemon yellow.

As the preparation of most of the above colors requires great care and a somewhat intimate knowledge of chemistry, and as the most delicate manipulations are necessary to secure accurate and satisfactory results, it is better for the mechanical operator to procure the coloring ingredients already prepared from some competent chemist, rather than attempt their production himself.

Manufacture of Porcelain Teeth.—The subjoined account of the processes concerned in the manufacture of porcelain teeth is

descriptive of those at present employed by most of our leading manufacturers.

The feldspar is first *calcined* by throwing it in large masses into a furnace and subjecting it to a red heat and then plunging it into water, which renders it brittle and easily broken by the hammer into small pieces, so that all foreign matters, such as mica or iron, with which it may be mixed, can be separated. It is then crushed between flint stones, and, when fine enough, is afterward ground under water in a mill in which heavy blocks of French bur-stone revolve upon a nether millstone of the same material until sufficiently pulverized, when it is floated off and allowed to settle. After this the water is drawn off or evaporated, and the deposit of spar dried and sifted.

The silex is subjected to the same treatment.

The kaolin, already of the desired consistency as found in nature, is prepared for use by first washing out impurities, and then drying.

The mineral ingredients are ground somewhat coarsely, but the coloring materials are reduced to an impalpable powder by means of a mortar and pestle machine of great power.

When properly prepared, the several materials are combined in suitable proportions to form the body and enamels, and are then mixed with water and worked into masses of the required consistency for molding. The degree of plasticity of the body and enamel pastes differs with the methods of manufacture. Formerly, the teeth, when molded, were first exposed to a heat just sufficient to produce partial baking of the body, and this was called cruising, or *biscuiting,* after which a thin paste of enamel material was applied with a camel's-hair brush, and the whole subjected to a second heat for complete and final fusion. This preliminary process of biscuiting is essential in carved block and continuous-gum work, but in most of the factories this partial baking is dispensed with, and the body and enamel pastes of the uniform consistency of putty are introduced into the molds, in the first instance, properly distributed, and final fusion effected by a single exposure to heat.

The molds are made of brass and are in two sections, one-half of the tooth being represented on either side. The exact form of the tooth is carved out with great care and precision, and must be anatomically correct and mechanically perfect, while the matrix is

made about one-fifth larger than the required size to compensate for shrinkage of the materials in baking. Holes are drilled in each half of the mold to receive the platinum pins, and the exact closure of the two pieces of the mold secured by guiding pins.

The molds having been previously oiled, and the platinum pins—which vary in length and thickness to meet special requirements—placed with small tweezers in the holes provided for them, the crown and gum enamels are first carefully laid in with small steel spatulas in the required quantity and position. The body is then added, in quantity exceeding somewhat the capacity of the mold, when the sections of the mold are closed upon each other and subjected to a pressure sufficient to insure compactness of the inclosed mass. When thoroughly dried by a slow heat, to which the molds are exposed, the teeth are readily disengaged when the matrix is separated, and will be found at this stage extremely friable and tender, requiring great care in handling them.

They are then sent from the molding to the trimmer's room, where, after critical inspection, all defective ones are either repaired or condemned, all excess of material cut smoothly away, and the arch of the gum over each tooth made true and smooth with fine pointed instruments. They are then placed on beds of coarse quartz sand, on fire-clay trays or slides ready for the furnace.

Referring to this stage in the process of manufacture, an intelligent observer writes:

"Beyond this no tool can follow them. Imperfections heretofore could be repaired, but in the future, beyond the fire, the tooth is either perfect or a failure irremediable. The furnace is an institution entitled to respect for its intensity. In its center is a muffle of fire-clay, entirely surrounded by the glowing fuel, a charge of half a ton's weight of coal, itself carefully bricked up before firing, that no impurities of dust or vapor shall reach the teeth. Take out the small, half-oval door of the muffle and you will see an inner glow the eye shrinks from registering, an incandescence that startles you by its fervor. In from fifteen to thirty minutes, teeth and fire-clay slide, glowing like the oven, are taken out finished. The dull enamel has become as glass. The lusterless oxids have yielded their color, and the tooth that went in friable and brittle has come out adamant. But there is an intermediate skill, the acquisition of which is one of the marvels of the mechanic arts. A little too long

in that heat and the teeth are ruined, and the evils of '*underdone*' are equally to be guarded against. It is a trained judgment, a skill of eye and handling that enables the burner to lend success to the work of those who have gone before him, and at the precise point where a shade of failure is utter ruin."

The teeth are now done and ready for the wax cards, on which they go to the trade.

CHAPTER XXII.

"CONTINUOUS-GUM" DENTURES.*

The process of uniting single mineral teeth to each other and to a metallic base by means of a porcelain cement was attempted as early as 1820, by Delabarre, of Paris, France, but with such imperfect and unsatisfactory results as induced its early abandonment. At a later period, Dr. John Allen, a distinguished practitioner of dentistry in America, devised a method embracing original and important modifications of practice, both in the preparation and combination of materials and the modes of manipulating them; and after an extended series of experiments, commencing in 1844, succeeded in obtaining certain mineral compounds which vitrified at a heat much below that employed by Delabarre, and the contraction of which corresponded so nearly with that of the platinum base to which it was applied that the shrinkage incident to baking conflicted in no material degree with the practical utility of the work in the mouth.

In the construction of dentures upon this principle, plain single teeth, made for the purpose, are arranged and soldered to a plate properly fitted to the mouth, after which different mineral compounds, made to represent the natural gum tissues, etc., are applied

* The attentive reader of the early editions of this work will not fail to note that the statements involving the question of *priority*, contained in the introductory portion of the above chapter, are at variance with those originally published. A more extended examination and careful analysis of the evidences as they appear upon record—evidences not fully accessible to the author at that time—established beyond reasonable doubt the just claims of Dr. Allen as the originator of that special and distinctive method here considered, by which the attachment of the teeth to the plate is effected by direct fusion of the gum material. Dr. Hunter's earliest and contemporaneous experiments contemplated simply a union of all the teeth by means of a fusible cement, forming a single, continuous block, which was afterward united to the base by riveting or soldering.

This brief explanation is here introduced as an act of simple justice to the late Dr. Allen, who devoted the best energies of his life to the successful development of a process which stands unrivaled in all the chief requisites of an artificial denture.

to the plate and teeth in a plastic state, then carved and trimmed in proper form, and by means of a strong furnace heat, these compounds, called the body and the gum enamel, are fused, producing a continuous and seamless artificial gum and palate resembling closely the natural structures.

The compounds at present employed in this process, as well as the more fusible preparations used for repairing purposes, are manufactured in quantities sufficient to meet the wants of the profession, and may be procured at all the dental furnishing houses throughout the United States.

The intimate but later identification of Dr. W. M. Hunter with the above process has rendered his name familiar as one whose skill and devotion to this specialty of mechanical practice has contributed to its development in a modified form. Dr. Hunter's formulas and modes of manipulating his compounds will be introduced hereafter.

Following Dr. Hunter's descriptions, the reader will find practical and valuable instructions in this method of substitution, contributed, at the solicitation of the author of this work, by Professors S. P. Haskell, of Chicago, Ill., and George S. Field, of Detroit, Mich., also the late Dr. Ambler Tees, of Philadelphia, Pa., whose long experience and intimate familiarity with the most approved methods of constructing continuous-gum dentures impart special value to the subject-matter of their communications.

Before introducing an account of Dr. Allen's modes of procedure, we would premise that it is unnecessary to repeat in this connection what has already been fully described in regard to impressions of the mouth, or the manipulations connected with the formation of plaster models and metallic swages, these processes being essentially the same as in the construction of ordinary gold work.

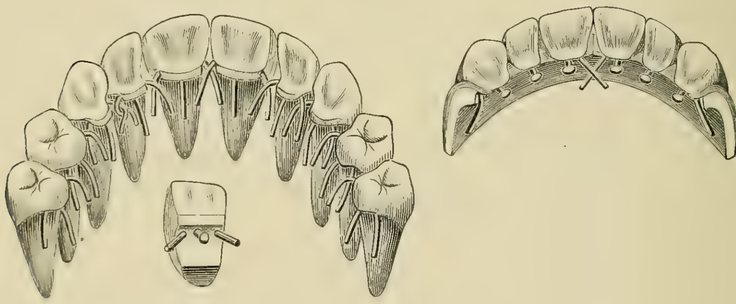
An ingenious method of attachment has been devised by Dr. C. H. Land, of Detroit, Mich. The improvement, in its application to continuous-gum work, is in the construction of the teeth, which are provided with three pins arranged transversely in the cervical portion of the tooth—one in the center and one upon either side on the posterior lateral aspect of the cervix, the latter being somewhat longer than the center pin. The long pins at the sides are so arranged that, when the teeth are in position, the lateral pins of all the teeth will cross each other, as shown in Fig. 109. The pins so crossed, and also the center pins, are pressed down closely upon

the plate, and the whole united to each other and to the base by flowing solder at the points where they cross, and at their line of junction with the base.

These teeth are designed more especially for continuous-gum work, but are applicable to dentures attached to gold plates by rubber or celluloid, and may be used also to advantage, in a modified form, in the use of rubber or celluloid alone.

The particular advantages claimed for these teeth are, that in their use in continuous-gum cases, equal or greater strength is imparted to a plate made much thinner than those ordinarily employed, say 32 to 33 Stub's gage, thus materially reducing the weight of the piece, while at the same time they offer greater facility and certainty in the manipulation of the gum body.

FIG. 109.



Dr. Allen's Methods.—The following descriptions embrace the methods and manipulations practised by the late Dr. John Allen in the construction of artificial dentures with continuous gums.

The plate or base is formed of platinum, or platinum and iridium. The plate being properly fitted to the mouth, and wax placed upon it for the bite, as in ordinary plate work, the teeth are arranged thereon with special reference to the requirements of the case. They are then covered with a thin coating of plaster mixed with water to the consistency of cream. After this has become firmly set, another mixture of plaster and asbestos with water, somewhat thicker or more plastic than the first, is placed round on the outside of the previous covering and the plate. A convenient way of applying the second covering is to turn the mixture out of the vessel upon a piece of tin, say four or five inches square, thus form-

ing a cone, upon which the plate, with the teeth upward, is pressed gently down until within an inch or less from the tin. Then with a spatula the mixture is brought up over the teeth, forming an investment that will not crack in the process of soldering. Sand may be used with the plaster for this purpose, but asbestos is preferable.

Attaching the Teeth.—When the covering has become sufficiently hard, the wax is removed, and a rim of platinum is then fitted to the lingual side of the teeth, below the pins, and to the base-plate. The pins in the teeth are then bent down upon the rim, and soldered with pure gold, or a mixture of gold and platinum, at the same time the rim is soldered to the plate. This rim, which forms the lining for the teeth, is usually about the thickness of the plate upon which they are set, say 28 to 30; but should the case require more than ordinary strength, a double or triple thickness of rim should be used. This may become necessary in cases where the natural molar teeth are standing firmly in the opposite jaw, and antagonize with the artificial piece, or where from any cause an undue strain is brought to bear upon the artificial teeth. To attain successful results, the dentist must take into consideration all the circumstances or conditions of each particular case, and then exercise his best judgment in executing the work.

In soldering platinum with pure gold, flat surfaces of this metal should be brought into positive contact, in order to become firmly united. Therefore, in mounting teeth upon a plate of this kind, the backing or inside rim should be a little wider than the distance between the pins in the teeth and the plate, say from 1/8 to 1/4 of an inch. This extra width of rim should be bent at right angles along the base of the teeth, so as to admit of being pressed down upon the plate after the rim is adjusted to the teeth, and the pins bent down firmly upon it. In this way flat surfaces of the rim and plate are brought together and soldered. The pins in the teeth are also soldered to the rim at the same time. When the parts are thus united, they will remain so during the subsequent bakings; but if the edge of the rim only is fitted to the plate and soldered like gold or silver work, the subsequent heatings for baking the body and gum will cause the gold to become absorbed in the platinum, and leave the joints not united. It is sometimes asked, Why not use common gold solder for this style of work? To this we would

answer, because the alloy in the solder will greatly injure the color of the gum enamel in baking. For instance, copper alloy will turn it to a greenish shade, and silver will give it a yellow tinge. Although pure gold requires more intense heat to melt it (being about 2000°) than ordinary gold solder, yet when melted it flows much more freely than the latter. The best way to solder the teeth upon platinum plate is to place small pieces of gold upon the joints or parts to be soldered, with wet ground borax, and then slowly introduce the piece with the investment into a heated muffle, and bring the whole mass up to a red heat; then withdraw it from the furnace, and bring it quickly under the blowpipe to flow the gold. In this way the teeth do not become etched, as they are liable to be if the soldering is done in the furnace.

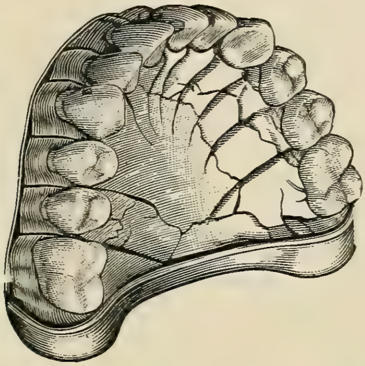
The piece being soldered and cooled, the covering is removed from the teeth, taking care to preserve the base unbroken for the plate to sit upon during the subsequent bakings of the body and gum enamel.

Preparing and Applying the Body.—All particles of plaster or other foreign matter should be removed from the teeth and plate by thoroughly washing and brushing them. It is well to immerse the piece for a short time in sulphuric acid, after which rinse and brush it well with water. This done, a colorless mineral compound, called the body, is applied in a plastic state (with spatulas or small instruments for the purpose) to the teeth and plate. It is then carved to represent the gum, roof, and rugæ of the mouth, taking care to keep the crowns of the teeth well defined. Small, clean cuts with a thin knife-blade should then be made, one between each of the teeth. Commencing with the space between the molars, the cuts should be made, externally and internally, entirely through the body to the stay and the plate. The object of these separations is to prevent movement on the part of the teeth from contraction of the body in baking, compelling the material to shrink toward the teeth and unite with them, leaving smooth and irregular openings where the incisions were made, into which more material is readily introduced and baked.

First Baking.—The piece is then placed on the base upon which it was soldered, and set upon a slide on the apron in front of one of the upper muffles of the heated furnace; and every few minutes it should be moved forward into the muffle, say two or three inches

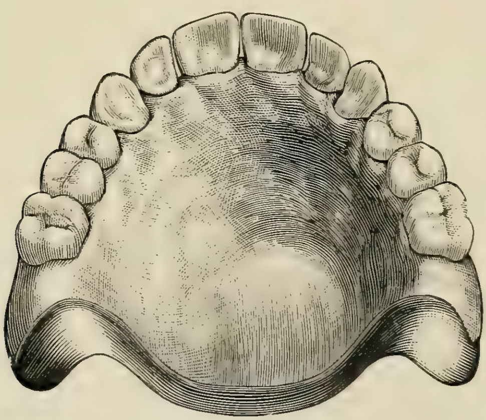
each time, until the piece shall have passed the center of the same, which should be at a red heat. It is then withdrawn and passed into a lower muffle, where the heat is greater, in which the body

FIG. 110.



soon becomes semi-vitrified, which is sufficient for the first bake. It is then taken out and, together with the slide on which it was baked, placed in a cooling muffle, the mouth of which should be

FIG. 111.



closed to prevent the change of temperature from being too rapid and causing the teeth to become brittle. Fig. 110 shows a case after the first heating. When the piece is sufficiently cool to handle,

a second application of body is made for the purpose of repairing any defects that may have occurred in the baking; this done, the piece is again introduced as before into the upper muffle, then into the lower, allowing the second bake to become a little harder than the first, but not so much as to appear glossy. It is then withdrawn, and cooled as described above.

Applying the Gum Enamel.—A flesh-colored compound is then applied, which is called the gum enamel. This is also made plastic with water, and a thin coating is put over the body and closely packed and carved around the teeth with small instruments made for the purpose, still taking care to keep the crowns of the teeth clean and well defined. Small camel's-hair brushes are used wet with water to cause the gum enamel, and also the body, to settle more closely around the necks of the teeth; other brushes are also used dry to remove all particles of body, gum, or other substances from the crowns of the teeth.

Final Baking.—After the application of the gum enamel, the piece is again subjected to the heat of the furnace as described for baking the body, with this difference: The heat should be a little greater than for either of the preceding bakes. It should be a strong, sharp heat, in order to produce a smooth, glossy appearance, which is required for the enamel. These different degrees of heat for the first, second, and third baking should be carefully observed for the purpose of getting an even temper in the piece, and thereby preventing it from crazing or cracking in cooling.

The enamel being thoroughly fused, the piece is withdrawn from the heated muffle, and passed into another, outside of the furnace. This muffle should be made quite hot before the denture is placed in it, in order to prolong the cooling process; for if the piece is cooled too rapidly it is rendered more fragile. It is well to let the case remain in the cooling muffle, with the mouth of it closed, several hours before exposing it to the air. By baking just at night the piece will be in proper condition to finish up the next morning. Fig. 111 shows the case completed.

The finishing process consists simply in smoothing and polishing the plate and burnishing the rim. It is then ready to be adjusted to the mouth. In baking, great care is necessary to prevent the piece from becoming gassed. This can be avoided by allowing the gas to escape entirely from the burning coal or coke in the furnace

before the piece is introduced into the muffle. The presence of gas is indicated by the blue flame escaping from the coal. When the fire becomes clear, it is then safe to introduce the case to be baked (as before described) into the muffle. Pure anthracite coal is the best for this purpose when the ordinary furnaces are employed, as it maintains a longer and stronger heat than coke. Bituminous coal is not good for this kind of work unless first converted into coke. With the electric furnace, however, the danger or possibility of gassing is entirely overcome.

It often occurs that the natural gums will change more or less after the teeth are inserted. In such cases a new impression should be taken from the mouth and a fusible die formed. The denture is then placed upon the die, and it will be seen at once where the change has taken place; then, with the piece resting upon the die, the artificial gum may be chipped off with a small hammer and chisel. The platinum plate, being soft, can be refitted to the die very accurately with a burnisher, hammer, and small driver made for the purpose. A new coat of body is then applied where the plate has been refitted, and then baked, cooled, enameled, and baked again—still observing the same directions as detailed in the management of new pieces.

Repairing.—If the tooth gets broken (a mishap which seldom occurs by use in the mouth) it can be replaced with another by grinding out the remaining portion of the broken tooth, and the gum covering the neck of same, and then fitting a new one in its place. This tooth need not be soldered to the inside rim; it is sufficient to grind a small notch or groove in the enamel which covers the lingual side of the rim for the pin of the tooth to fit into. The pin resting in the groove is covered with the body at the same time it is applied around the base of the tooth, and when this body is baked the tooth will become firmly fastened in place of the broken one. Any number of teeth that may be required can be replaced in this way. If it is desired to change the position of one or more teeth, or to make them longer, this can also be done as described above, with the additional precaution, to press softened wax upon the inside of the teeth and palatal arch of the denture before the others are removed—this wax will serve as a guide or index as to the relative change to be made, and also to sustain the teeth in place while they are being fitted as desired to the denture. The wax soon becomes hard, and

is readily removed as each successive tooth is ground and adjusted in its proper place.

When the teeth are thus fitted with each pin accurately pressed into the groove prepared for it, and the wax being placed upon the inside to support the teeth in the proper position, body is filled in around the base of the new ones, which are carved, trimmed, and brushed, so as to save the crowns of the teeth clean and properly defined. The wax is then carefully removed from the piece, and more body is filled in around the teeth upon the inside—filling up the grooves over the pins, and then carving, trimming, etc., as before, to give it the desired form. This done, if the teeth are set a little apart, and it is desired to keep them in that position, take a little piece of asbestos and gently press it in between the teeth at the cutting edges; this will prevent them from being drawn together when the body is being baked. The piece is now ready for the furnace, but it should not be baked hard enough to gloss the newly-applied body; it should have more the appearance of Parian marble.

This being done, it is then withdrawn from the furnace and transferred to a cooling muffle, as before described. When sufficiently cool, the gum enamel is applied and baked with a sharp heat until it becomes smooth and glossy. To prevent the old gum from bleaching or becoming lighter colored in consequence of repeated bakings, a very thin coating of fresh gum enamel should be lightly brushed over the entire enameled surface of the piece. The enamel thus applied should be mixed with water, quite thin, so as to flow evenly over the surface when applied with a camel's-hair brush. This should be done before the last baking, that the whole may be fused at the same time. Experience and judgment are essential requisites in order to produce good practical results. For example, if the carving of the body is not properly done, the form and shading of the gum and roof will not appear natural when the work is finished; if the gum enamel is put on too thick, it will produce a dark red color; if not thick enough, it will be too light; if fused too hard, it will be liable to craze or crack; if not hard enough, it will be rough or granular; if the piece becomes gassed in baking, it will be porous and of a bluish color.

Dr. Haskell's Methods.—"It should be borne in mind," says Dr. Haskell, "that the strength of this work depends mainly

upon the *metal,* and not upon the *porcelain,* though the latter adds to its strength. While platinum is a very soft metal, yet, by means of various devices, the plate, with the teeth properly soldered on, and ready for the porcelain, can be made very stiff and strong, therefore everything that can be done to secure a strong foundation should be carefully observed.

"The plate should be of the best French material (not melted scraps and old plates), 29 to 30 gage for the upper, and 26 to 28 for the lower, and should be swaged on Babbitt metal dies. The plate is then tried in the mouth, and if the fit is found to be correct, arrange the articulating wax, secure the 'bite,' and make the articulating model.

"The back of the plate should be doubled, for the following reasons: It imparts increased strength; leaves some margin for change, in case of necessity, after the work is in the mouth; protects the edge of the porcelain, and admits of a neater finish. This 'doubler' should be about $\frac{3}{16}$ of an inch wide, with the edge turned up slightly to receive the porcelain. Around the outer edge, solder a flattened wire, $\frac{1}{16}$ of an inch wide, or less, and 22 gage, bringing the ends to meet the turned edge of the doubler. This strengthens the plate, and affords a good round finish to the edge, as well as protection to the porcelain. This is easily put on after a little practice, and is far preferable to *turning* the edge of the plate with pliers, or otherwise. Pure gold should always be used for soldering, and with just enough borax (using very little) to give direction to the flow of solder.

"Then comes the arrangement of the teeth, and this should always be done in the mouth, the articulating model being only a preliminary guide; for by the mouth alone can one determine the correct expression and arrangement desired; and it is just here that three-fourths or more of the artificial dentures fail in an utter lack of artistic skill. In this work there is ample opportunity for the display of taste and skill, so that perfection itself is attained at the hands of the true artist.

"The *investing* process comes next. First, a coat of shellac over the teeth to prevent etching (although, if this occurs, it is not a matter of much account, as the baking remedies it). Then a *thin* coat of clear plaster; next plaster and asbestos, one part of the latter to two of the former. Let the portion under the plate extend

at least one inch back of the latter, as this bottom portion is to be retained on which to bake the case; invest the whole ½ of an inch thick. Warm the case until the plate is sufficiently heated to remove the wax easily; dash boiling water over it (this is the best method to remove wax adhering to teeth and plate in all kinds of work). The backings should be *continuous* and be *lapped* on to the plate, for in this is the mainstay of the work for strength. Cut patterns in tin or lead, three pieces, one for the six front teeth, and one for each side, lapping over the cuspid teeth; the foot-piece should lap on to the plate about $\frac{3}{16}$ of an inch. No borax is needed. The gold should be melted and rolled into a ribbon as thin as possible, and cut in small pieces and laid under the lap, or foot-piece, and a piece under each pin. The backings can be fitted more easily by splitting the foot-piece. The most convenient method of soldering is in the furnace, being careful not to let it remain too long, so as to fuse the enamel on the teeth. If a pin should fail to solder, it is immaterial, as the 'body' will hold it.

"After cooling, remove the plaster and save the base. Place the plate on the articulating model, and if it is sprung, press it into place, which is very readily done.

"Apply the 'body' mixed with water, quite thin, by means of an oval-pointed knife, occasionally jarring with handle of spatula, and as the moisture comes to the surface, absorb with a cloth; after it is well filled into all interstices, apply it thicker, jarring, absorbing, and packing hard, until enough is on the outside to produce the proper shape and contour of the lips. Then apply, with the *curved* point of the knife, the body to the lingual side of the plate, same as on the outside, but only a thin coat on the plate. Trim around the necks of the teeth, remove all particles from *between* with a quill toothpick, and brush all particles off the surface of the teeth and exposed portions of plate, and the case is ready for baking.

"The furnace shown in Fig. 26 is preferable; and in setting the 'muffle,' see that the vent hole in the top is clear; this is for escape of gas that may be in the muffle and would injure the work. Fasten the front end with fire-clay, but leave the back end free. Set the case 10 or 12 inches from the opening, move forward, every few minutes, a couple of inches, until it is in the muffle; place it within two inches of the back, and close the door. If the heat is right,

five or ten minutes will suffice; still, it must be looked at so as not to get too much heat. This first bake should be only a glaze. Remove to a muffle on the hearth and close up tight. When cool, place on the model, and, if sprung, press it into place. Next fill up all the cracks with very thin body, jarring with handle of the spatula often, so that the material will fill up thoroughly; then spread on thicker until the proper shape and fullness are secured, trimming around the teeth, and doing as previously described, and bake as before. After cooling, the enamel is to be put on the same as the body, applying only a thin and uniform coat. The rugæ can be produced in the body or in the gum. The enamel should have a thoroughly glossy appearance when ready to be removed from the furnace. Heated cooling muffles are unnecessary, as the case itself will heat the muffle all that is necessary.

"Lower sets are better without a binding, as it is sometimes necessary to file or grind away the edge.

"The case is finished by filing and polishing the exposed metal surface, not doing anything to the upper surface.

"A 'defined' air-chamber is rarely necessary; a Cleveland chamber never. Raise the plate over the hard palate with a thin film of wax on the plaster cast, chamfering off the edges completely; scrape the plaster model across the back, except right in the center, according to the softness of the palate.

"This work *is not advisable* for partial sets, except in some partial lower cases where there are no detached teeth. In these cases the plate should be at least two thicknesses across the back of the front teeth, and resting well up on the necks of the same.

"**Repairing.**—Very few seem to know how to *prepare* a case for repairing. Invest it in plaster and asbestos at least ½ of an inch deep; place in the muffle before lighting the fire, and allow it to remain with the door open, as the fire comes up, until it is *red hot;* then remove, cool, and thoroughly clean off the plaster, preserving the *base,* and it can be run into the furnace with as little danger of cracking as if it had never been worn.

"Grind out the remains of the teeth below the margins of the gum; select a *rubber* tooth, as it is easier to get and just as good as one made for this work, filing off the pins; hold with wax until a little plaster and asbestos can be placed over it and the adjoining

teeth; thoroughly remove the wax and put on *repairing* body, and bake; cool, put on the gum, having previously ground off a portion of the old gum if it is a very old case, and put on just a little new, and bake as at first.

"If blisters occur, grind into them and fill with *body and gum,* three to one, press hard, and enamel."

Dr. Ambler Tees' Methods and Formulas.—The late Dr. Tees described his work as follows: "Continuous-gum work is mounted upon a swaged plate of pure platina, about No. 29, American gage. The lowest plate, to insure strength, is made of two pieces soldered together, one being large enough to allow for a rim. In a partial lower set, an additional piece of iridionized platina is soldered to the part covering the lingual gums of the remaining natural teeth. Plain teeth, with single long pins, made for the purpose by tooth manufacturers, are soldered to the plate with pure gold (24 k.), which alone is used as a solder in this work, since the copper and silver contained in alloyed gold will discolor the *gum enamel.* The silicious materials called *body* and *gum enamel* are then applied around the necks of the teeth, and upon the lingual portion of the plate, by means of small spatulas, and carved to imitate the contour of the gum.

"The investment used for retaining the teeth in position while being soldered is composed of two parts of plaster and one of asbestos; before applying this, the teeth should be coated with a thick varnish of shellac and alcohol, to prevent the teeth being etched in soldering. The backing is fitted most conveniently by making it of three pieces; the pins are bent down over it, and soldered with pure gold. After soldering, the investment is removed, and the teeth and the plate brushed with soap-suds and powdered pumice-stone and washed off with clean water. The *first coat of body* is then applied, moistened with clean water to the consistency of soft putty, as a foundation, no effort being made to imitate the contour of the gums; separations, however, are made between the teeth, so that the body may fuse around each tooth separately, and prevent it being drawn from position by the shrinkage of the body. It is then *fused* in the muffle, and placed in a *cool* muffle for thirty minutes. After adjusting it upon the articulator, it is ready for the *second coat of body.* In applying this, an artistic effort is made to imitate the contour of the gums; and by making elevations and depressions in appropriate

position, the lights and shades of the natural gums may be simulated, especial attention being paid to the rugæ. This coat is *vitrified* and not fused. After it is cool and again adjusted upon the articulator, the *gum enamel* is applied, the spatulas being used for the purpose. It is moistened with clean water, a little thinner than the body, and laid on a little at a time, about the thickness of 26 plate. This is *fused* and allowed to remain in the cool muffle for an hour and a half. The platina is then rubbed with pumice-stone, an orange-wood stick being used, and the rim filed, stoned, and burnished, when the set will be ready for the mouth.

"When a set is to be repaired, the mucus should be burnt off before any fresh body is applied. To accomplish this, it should be invested in plaster and asbestos, and heated to redness over a gas or coal-oil stove, or upon the coals in a range. The investment should then be removed, the set washed with soap-suds and pumice-stone, and again heated to redness upon a slide in the muffle. The new tooth, after being carefully ground against the gum, is held in position by plaster and asbestos on the palatine surface, a very small quantity being sufficient; after it has set, *gum enamel* is worked into the joint at the neck and fused in the muffle. The body and gum enamel are then applied to the palatine surface, after the pin is soldered to the old backing, and then fused. This plan obviates the old method of investing the whole set in plaster and asbestos."

Body and gum enamel for continuous-gum work was manufactured by the late Dr. Tees, according to the following formulas and methods of compounding:

He furnished three shades of gum enamel—pale, medium, and dark. The body as made by him is composed of:

Feldspar,	2 ozs.
Dental glass,	8 dwts.
Kaolin,	3 dwts.

The materials are ground together in a moistened state, in a wedgewood mortar, for about an hour; then dried; again ground for ten minutes, and fused in a crucible in a coke fire, or upon a slide in the muffle. After being pulverized, two grains of titanium to each ounce are added and thoroughly mixed.

The gum enamel is composed of:

Feldspar,	2 ozs.
Dental glass,	10 dwts.
Gum frit,	½ dwt.

These materials are ground together in a moistened state, for about an hour, in a wedgewood mortar; then dried, ground again for ten minutes, and fused—upon a slide rubbed with fine, dry silex—in the muffle of the furnace; again pulverized, and sufficient additional gum frit mixed in with a spatula to give the desired shade.

The materials fuse readily and will not check in cooling.

Application of Continuous Gum to Partial Sets.—The following method of constructing partial sets of artificial teeth with continuous gum is taken from a practical paper on this process by Dr. W. B. Roberts:

"Partial cases may be made of continuous gum; but the work is so various in its nature that the dentist must necessarily depend much upon his own judgment. Difficult cases will constantly present themselves that will require the exercise of much study and ingenuity, in which the general instruction that can be given in words may be of but little service. The first attempt of this kind in my own experience was in replacing two central incisors. Taking two continuous-gum teeth, I placed upon them a platinum lining, slitting this down along the edge of one tooth nearly through the piece and up the edge of the other tooth by a parallel cut, leaving the two parts joined together by a narrow slip. This allowed sufficient motion between the teeth, so that they could be adjusted as desired. I then placed a small piece of tissue-paper on the plaster model, covering the spot to be occupied by the teeth and gum, to prevent the adhesion of the body to the plaster, and holding the two incisors in their places, worked the body into all the depressions of the gum and around the roots of the teeth. It was then all removed from the model, and placed in a paste of pulverized silex, or plaster and asbestos, upon a slide, and baked as described for full sets. The little slip of platinum kept the two teeth in place. The work shrunk somewhat; but this was remedied by again placing the piece upon the model with the intervention of tissue-paper covered with a thin coating of body. Into this I pressed the piece till it occupied its true place, and then filled in again with more body all the crevices around the roots of the teeth, and rebaked.

"After enameling, if the work has been carefully and skilfully done upon this plan, it will be as fine a piece in appearance and fit as can be made. It may then be soldered to a gold plate, and the little strip of platinum between the teeth be cut out. With the body and gum formerly in use many difficulties were encountered from discoloration of the gum, or from other injuries incurred in soldering. But with Roberts' material these are easily avoided, and the piece can be treated the same as block or single gum teeth. In partial sets on entire plates of platinum trouble has sometimes been experienced by the enamel giving way upon the small narrow points that connect the teeth with the plate by the shock occasioned in biting, consequently I have left these points uncovered, and used two or three thicknesses of platinum to give greater strength. But where this is likely to occur, gold plates would be preferable, if nicely adapted with single gum teeth, or blocks of continuous gum, as the case might require. I have also applied continuous gum in cases where the natural teeth, from one to five in number, were left in the mouth, by making the plates as in full sets, cutting out around the natural ones, and raising a small bead, or placing a light wire around, about ⅛ of an inch or more from the teeth, against which the gum or body is to be finished. The points around the teeth are to be left free, in order to be burnished down in cases of imperfections caused by the difficulty of obtaining exact impressions in these places. In such cases I sometimes form a strong standard of several thicknesses of platinum fitting closely against one or more natural teeth, leaving a loophole through which to run a gold clasp for afterward securing the artificial set.

"I have also secured the gold to the standard by rivets of platinum, and sometimes by two or three gold screws, not providing, in these cases, the loophole. These methods are to be preferred to using solder for fastening; for, in case of repair, the clasps are easily removed without leaving any foreign substance; but in case of soldering, however carefully they may be removed, there will remain some alloy, which in the baking heat to which the piece is to be exposed will be incorporated with the platinum. Even so small an amount of silver as may be in gold coin used for solder will communicate a yellowish tinge to the gum, spoiling the whole work. Many operators in their early practice experienced this result, and learned that no alloys, especially of silver or copper, can be admis-

sible for soldering this work. I have tried platinum clasps without success, as no elasticity could be obtained, and therefore would not hold upon the teeth. Another source of mischief may properly be noticed in this place. In baking, especially with a new furnace, or with muffles lately renewed, either at the first or second heat, or it may be enameling, the piece is sometimes changed in its texture and color, as is supposed, by the gases present, and the phenomenon is called gassing the piece. The body becomes porous and of a bluish color. When this occurs there is no remedy but to place it on the metallic die, remove the whole of the injured part, and replace it with a new coating of body and gum. The teeth are seldom, if ever, thus affected. As a precaution, the muffles should be well ventilated with holes for the passage of the heated air and gases."

CHAPTER XXIII.

RUBBER OR VULCANITE BASE.

While there are undoubtedly many important uses to which vulcanized india-rubber may be applied in the practical departments of dentistry, and for which it would be difficult to find an adequate substitute, yet there are accumulating evidences leading to the conclusion that its abandonment, as a base for artificial dentures, by intelligent and conscientious practitioners, except in rare cases, or where, for pecuniary reasons, a more expensive base is not admissible, is an event of the not distant future.

This anticipated result, in respect of a material which has been almost universally employed as a base for the past twenty years, is assured by the confirmed and steadily increasing distrust of its suitableness for the purpose indicated, and the growing tendency in the profession to return to higher and less objectionable forms of substitution in respect to material and construction.

While the statements made in former editions of this work in regard to rubber as a base reflected, as the author believed, the estimate of its fitness by the profession generally, what is now written, the editor believes, embodies the present judgment of the mass of enlightened practitioners in reference to its unsuitableness as a base for artificial dentures.

General Properties of India-rubber.— Caoutchouc, gum-elastic, or india-rubber exists as a milky juice in several plants, but is extracted chiefly from the *Siphonia cahuca,* which grows in South America and Java. It is discharged through the numerous incisions made in the tree through the bark, and is spread upon clay molds, and dried in the sun, or with the smoke of a fire, which blackens it. The juice when first obtained is of a pale yellow color, of about the consistency of cream, and has a specific gravity of about 1.012. In the process of drying 55 per cent. is lost, the residuary 45 being elastic gum. It immediately coagulates, by reason of its albumin, on application of heat, the elastic gum rising to the sur-

face. The specific gravity of the juice is diminished by inspissation, becoming 0.925 when hard, and cannot be permanently increased by any degree of pressure. When once stiffened by cold or continued quiescences it cannot be restored to its original condition of juiciness.

The inspissated juice, or crude rubber of commerce, is altogether insoluble in water or alcohol, but is readily soluble in ether deprived of its alcohol by washing, affording a colorless solution. On evaporation of the ether, the gum resumes its original condition. It swells to thirty times its bulk when treated with hot naphtha, and if triturated in this condition in a mortar, and pressed through a sieve, furnishes a homogeneous varnish employed in the preparation of a waterproof cloth.

Caoutchouc is soluble in the fixed oils, but is not readily decomposed by cold sulphuric acid or diluted nitric acid, and is unaffected by either muriatic acid gas, sulphurous acid gas, fluosilicic acid, ammonia, or chlorin, nor is it dissolved by the strongest caustic potash lye, even at a boiling heat, and is therefore highly esteemed as an appliance of the chemical laboratory. According to the experiments of Ure, Faraday, and others, caoutchouc contains no oxygen, as almost all other solid vegetable products do, but is a mere compound of carbon and hydrogen, in the proportion of three atoms of the former to two of the latter. From this property of resisting the corrosive action of acid vapors, and its tenacity of adhesion to glass, caoutchouc, when melted, forms a very excellent lute for chemical apparatus.

Such are some of the properties of this remarkable product, the uses of which have been almost immeasurably extended since the first successful efforts to produce artificial induration by Charles Goodyear in 1844.

Compounding Rubber for Dental Purposes.—India-rubber is prepared for vulcanizing by incorporating with it, in varying proportions, either sulphur alone or some of its compounds, sulphur being an essential component of all vulcanizable gum compounds. For dental purposes, the coloring is effected in most preparations by the introduction of vermilion (sulphuret of mercury). These substances, properly combined, are subjected to artificial heat for a specified time, producing a hard, horn-like substance, possessing the qualities of lightness, strength, durability, imperviousness to

fluids, insolubility in the oral secretions, unchangeableness on exposure to ordinary temperatures, etc.

Method of Constructing an Entire Denture in a Base of Rubber.—As the manipulations concerned in the construction of a full upper set differ in no essential respect from those required in the formation of a denture for the inferior arch, except as the two differ in conformation, requiring corresponding modifications of practice which will readily suggest themselves, it will be sufficient to describe the method of constructing an entire denture for the upper jaw.

An impression of the mouth is first secured in the usual manner, and, as has been stated, plaster-of-Paris is preferable to any other material for the purpose. As rubber, when rendered plastic by heat and subjected to pressure, receives a distinct and perfect impress of the face of the model, it is important that the latter should be as smooth upon its surface, and as free from faultiness of form or surface blemish, as possible. From the impression a plaster model is obtained, and if an air-chamber is required, it may be secured either by cutting out from the impression before filling in with plaster, for the model, or it may be raised upon the model after the latter has been separated from the impression. For the latter purpose lead is often used, but sheet-tin, cut to the required form, is preferable, as the former leaves a tenacious coating of oxid adhering to the plate.

A temporary or model base-plate is next conformed as accurately as possible to the face of the model, and for this purpose the *prepared gutta-percha,* paraffin, and wax, or modeling compound worked into thin sheets may be used, or a die may be secured and a trial plate struck up from block tin. Though the latter requires more labor, it gives more satisfactory and accurate results. The former may be softened either by subjecting them to a dry heat until sufficiently plastic, or by immersing in hot water. The face of the model being previously well saturated with cold water to prevent the wax or gutta-percha from adhering, the latter is pressed or molded accurately to the model with the fingers moistened with cold water, heating such portions from time to time as do not readily yield to pressure until an accurate adaptation of all portions of the plate is secured; then trim to the required dimensions.

Having fitted the temporary plate to the model, it is placed in the mouth with a wax guide or rim attached, when the latter is trimmed to the required width, fullness, and contour, and the "bite" of the under teeth secured; it is then removed and placed in its proper position on the model, which is placed in an articulator, with the antagonizing model, the latter being obtained in the manner described in connection with the metallic plate-base (page 242). The mode of procedure in cases of entire dentures for the upper and lower jaws differs in no respect from that practised when gold or other metallic plate is used as a base.

Arranging the Teeth.—Having secured an antagonizing model, the teeth are selected and arranged upon the temporary plate in the usual manner. The porcelain teeth used in this process are more commonly in the form of blocks or sections. Figs. 112 and 113

FIG. 112.

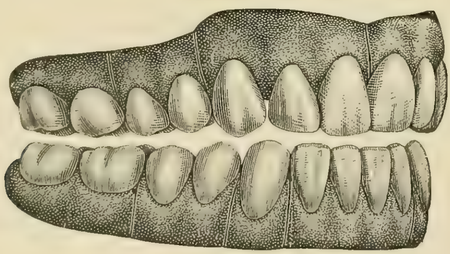


exhibit the marked peculiarities, and the proper arrangement of an artistically designed set of gum or block teeth. The increased strength of attachment formed by the greater number of pins also renders them more permanent and enduring than single gum teeth. Teeth made expressly for rubber base were originally manufactured with plain platina pins, longer and heavier than those used in connection with metallic plates. These, when used, were curved and pressed together, forming loops or hooks to prevent them withdrawing from the rubber. Subsequently, however, the detachment of the teeth was more securely and certainly provided against by the substitution of headed pins, which rendered their withdrawal from the rubber impossible. For this valuable improvement the profession is indebted to the late Dr. S. S. White, whose genius, enterprise, and intelligence were so long and unceasingly tributary to the needs of the dental practitioner.

Fig. 113.

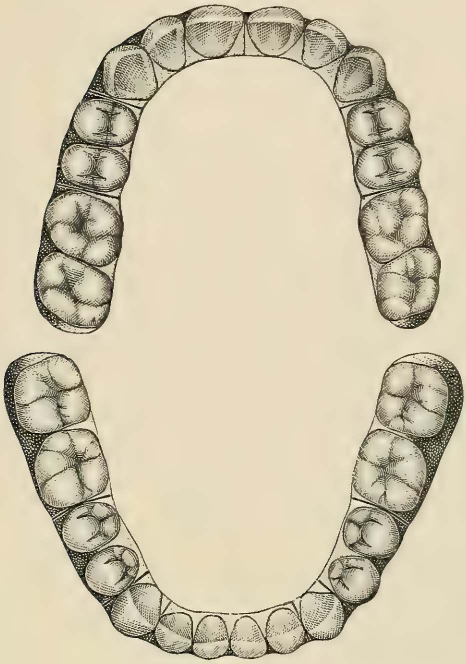
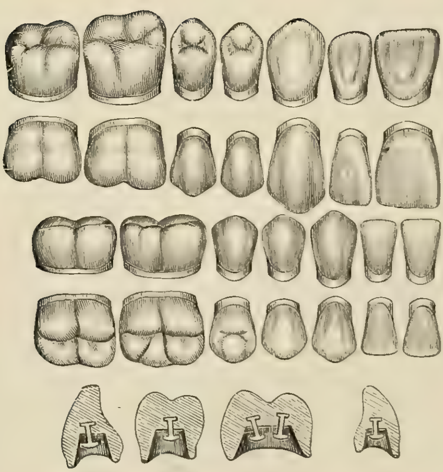


Fig. 114.



The latest design in the construction of porcelain teeth is shown in Fig. 114. The base of the tooth is countersunk, with headed pins inclosed within the cavity. It is claimed that their close conformity in contour to the natural organs makes them much more acceptable to the tongue than teeth backed in the ordinary manner, renders articulation easier and more distinct, and prevents disclosure of artificiality when the mouth is opened. In addition to these advantages, they allow greater facility of adaptation to the maxillary ridge. They are particularly adapted to rubber base with celluloid facing, or to celluloid base alone. Other forms of plain teeth are placed upon the market, and when they can be employed more artistic results may be secured than is possible with the gum teeth.

Grinding and Jointing the Teeth.—In arranging the teeth, portions of the wax rim are cut away to form a bed for each tooth or block, as the case may be, grinding from the base of the latter and from their proximate edges until the proper position is assigned to the teeth, and the required antagonism is secured. When gum teeth are used; whether single or in the form of blocks, they should be united to each other laterally with the greatest possible accuracy, to prevent, as far as practicable, the intrusion of the gum material between them. To further provide against this, various expedients have been resorted to with the view of cementing or packing the joints in order to render them impervious to the rubber. The substances usually recommended for this purpose are plaster or finely-pulverized silex or feldspar moistened with dilute liquid silex, os-artificial, soluble glass, gold, or tin-foil, or fusible metal packed into the joints, etc. Of the more destructible substances mentioned, Professor Wildman very justly observes: "All of these, in course of time, will yield to the action of the fluids of the mouth; and then the ill-fitted joints will be receptacles for soft particles of food, which will be more objectionable than having them filled with good, solid rubber. *The best filling is an accurately fitted joint;* when so made, if the enveloping plaster is of good quality and properly mixed, and no undue force is used in bringing the section of the flask together, there is little danger of the rubber insinuating itself into the joints." As properly remarked, there is no expedient which will so certainly and effectually exclude the rubber as *close-fitting joints,* and if the precaution is taken to secure an accurate and uni-

FIG. 115.

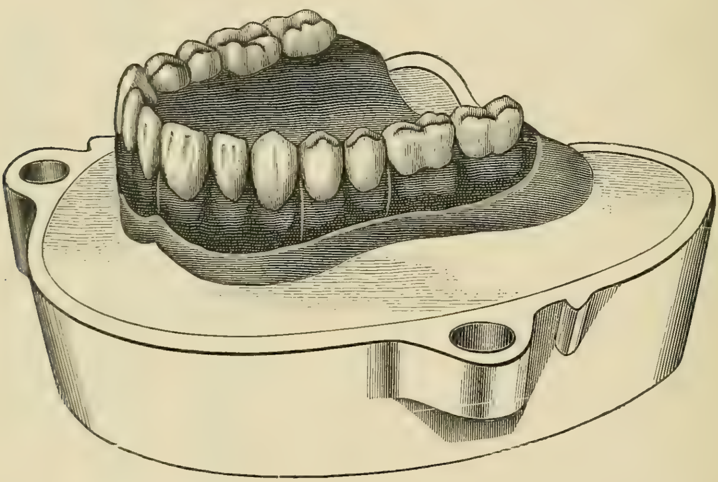
form coaptation of the ground surfaces where they unite in front, and the "enveloping plaster is of good quality and properly mixed, and no undue force is used in bringing the sections of the flask together," there will, at most, be but a very thin film of rubber, nearly imperceptible in the finished work, and wholly so in the mouth. To better effect the object stated, the writer has been accustomed, when uniting porcelain blocks, to use a small magnifying glass, which reveals inaccuracies of coaptation not apparent to the naked eye.

The teeth having thus been properly united and arranged, the wax rim supporting them on the lingual side should be cut away and carved with heated instruments, especially designed for that purpose, as represented in Fig. 115, until the required form and fullness are obtained, adding wax, if necessary, to the palatal portion of the plate, making it just enough thicker than that required in the completed set to compensate for waste in the process of final finishing. Any considerable excess of material should be avoided, since it will not only materially increase the labor of dressing the vulcanized plate, but tend to induce porosity or sponginess of the rubber under heat. A rim of wax should also be extended around the front and lateral borders of the plate, overlapping somewhat the extremities of the gum portions of the teeth. Wax used for the purposes indicated should be of the cleanest and purest varieties. A set

modeled in the manner described will present the appearance represented in Fig. 116.

Flasking.—The process having been conducted thus far—any defects in the arrangement of the teeth having been previously corrected upon trial of the plate in the mouth—the next step in the operation is the formation of a mold or matrix in which the gum material is packed and pressed preparatory to being vulcanized. In forming a matrix, a vulcanizing flask is used, the forms of which are separately represented in Figs. 121–125. The lower section of the flask is first filled one-half or two-thirds full of plaster mixed with water to the consistency of cream. Into this the base

Fig. 116.



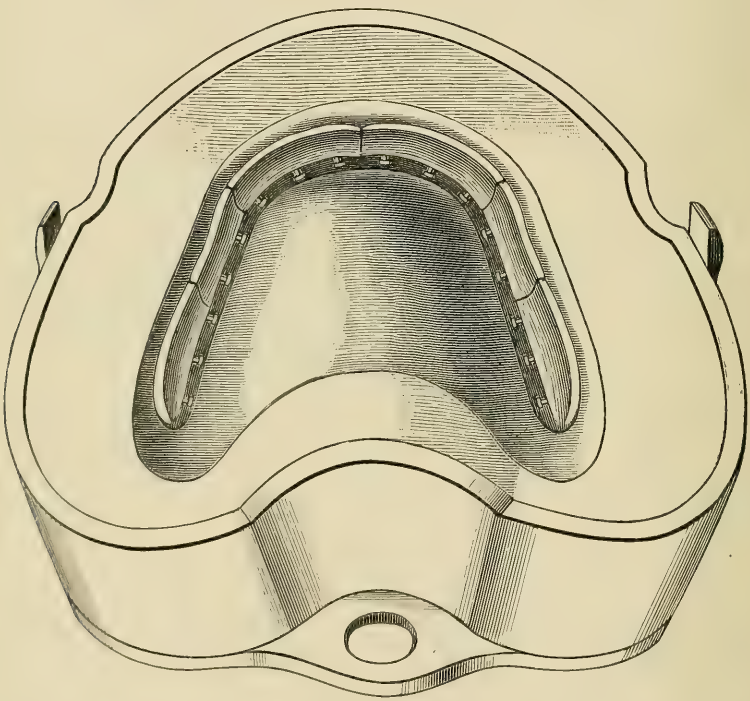
of the model, previously moistened with water (the plate and teeth being attached to the model), is immersed and additional portions of the plaster added, if necessary, filling the cup even with the upper edge, and extending it up the sides of the model, to the lower edge of the external rim of wax attached to the borders of the gum plate. The base of the model should be cut away, so that when placed in the flask the lower edge of the gum plate will extend but little above the level of the upper borders of the cup. The surface of the plaster is then trimmed smoothly, and coated with varnish and then oiled; all the exposed portions of the gum plate and wax are also oiled, leaving the surfaces of the teeth untouched. The

several parts will now present the appearance represented in Fig. 116. The upper section of the flask is next placed in its proper position over the lower—the slides formed in one, and corresponding grooves in the other, determining an accurate relation of the two pieces. Into the upper rim of the flask, plaster, mixed to the consistency before mentioned, is now poured, filling it completely. The lid or cap is then applied to the opening above, and the several parts of the flask brought firmly together, forcing the excess through the joints of the flask. As soon as condensation of the plaster takes place, the flask should be placed in a hot-air chamber or on a stove, and heated throughout *just sufficiently to soften, but not melt the wax.* The flask should be heated gradually, otherwise the contents may be suddenly and forcibly ejected, in consequence of the too rapid evolution of vapor. The two sections of the flask are then carefully separated by forcing the blade of a knife or a small chisel-shaped instrument in at different points between them, the lid closing the opening above remaining in place. On separating the flask, the teeth, with the wax and temporary plate, will be found attached to the section of the matrix last formed, the portions of the crowns of the teeth not covered with wax being imbedded in the plaster and their plate extremities presenting toward the matrix, as seen in Fig. 117. The base-plate and wax should now be carefully detached with such instruments as will best enable the operator to work out confined portions around the platinum pins and from the interstices between the teeth, being careful at the same time not to deface the plaster surface of the mold. To relieve the matrix more perfectly of all traces of wax not accessible to instruments, the section containing the teeth may be subjected to a small stream of boiling water, which should be dashed upon it until every trace of wax is removed.

Before packing the material, provision should be made for the escape of any excess when the matrix is filled and the two sections of the flask are forced together, permitting the latter to close upon each other in exactly the same manner as before the introduction of the gum. If the vulcanizable substance becomes engaged between the surfaces of the plaster around the matrix, the vulcanized base will be increased in thickness just in proportion to that of the interposed layer of gum, and hence the teeth of replacement will be relatively elongated. This increased thickness of the base

and consequent changed relation of the teeth to the maxillary ridge and to those of the opposing jaw, if but slight, may be immaterial in the application of full sets of teeth; but it is far different in the construction of partial pieces, where the perfection of the finished work depends in so great a degree upon a faultless preservation of the exact position originally assigned to the organs of replacement in the several vacuities on the ridge. If, for example, in replacing

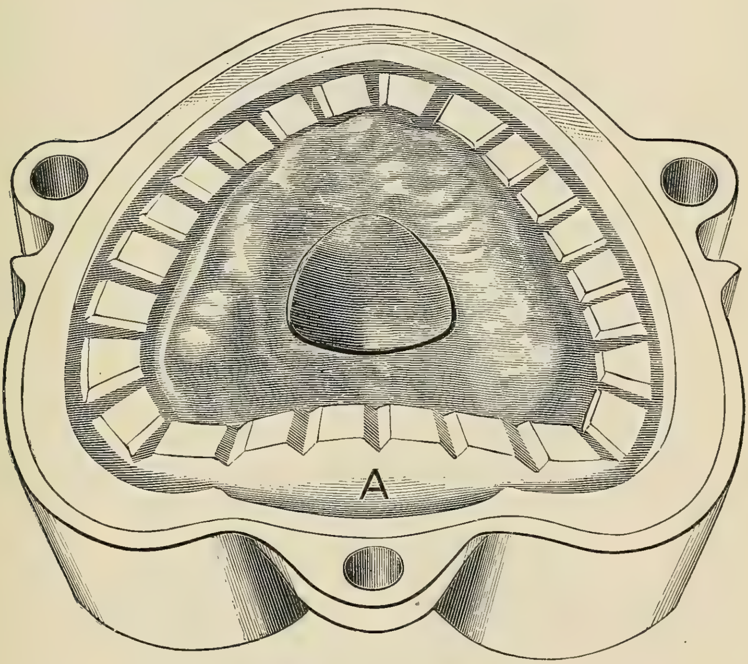
Fig. 117.



the superior incisors, the approximation of the two sections forming the mold is obstructed by the intrusion of the gum material between the plaster surfaces, the teeth, whether plate or gum, will be relatively elongated in proportion to the increased thickness imparted to the base consequent upon the incomplete closure of the flask, and however accurately or skilfully the porcelain teeth may have been originally fitted to the vacuity in front, the artificial will be found to depart from the natural gum, while the porcelain crowns

will be displaced and projected below those of the contiguous natural organs. Such displacement in the cases last referred to, however small in degree, cannot fail either to impair or destroy the value, both as respects appearance and utility, of the substitute. The method of furnishing an exit to redundant material, as usually practised, is to form a series of conduits or grooves in the surface of the plaster, extending them from the edge of the matrix to the rim of the cup. The escape of the gum will be facilitated by cutting

FIG. 118.



notches at intervals around the rim of the flask, making the grooves in the plaster continuous with them, the grooves being about 1/4 of an inch apart. To still more effectually prevent the intrusion of the vulcanite material between the surfaces of the opposing sections of plaster, a circular groove may be cut in the plaster within a line or two of the margins of the matrix, as is shown in the illustration, Fig. 118, into which narrow channels at short distances are made, leading from the mold; others, again, are made at wider intervals

from the circular groove to the outer margins of the flask, terminating as before in small notches found in the rim of the cup. The two pieces when closed upon each other form a matrix. Into the grooved section of the mold, the vulcanizable substance is packed previous to being indurated. It is at this stage that the materials employed to exclude the rubber from between the teeth, and noticed in another place, are packed into the joints before the gum material is introduced. The face of the model should also be coated with some substance which will prevent the rubber from penetrating the pores of the plaster and its adhesion to the surface of the model. Preference is given by Professor Wildman to liquid silex, as being more readily detached from the surface in finishing than the preparations mentioned. Whatever is used, it should be allowed to dry perfectly before packing. Other methods, and good ones, are to burnish a sheet of tin-foil over the cast, or sprinkle lycopodium or soapstone upon the surface of the cast. These latter should be

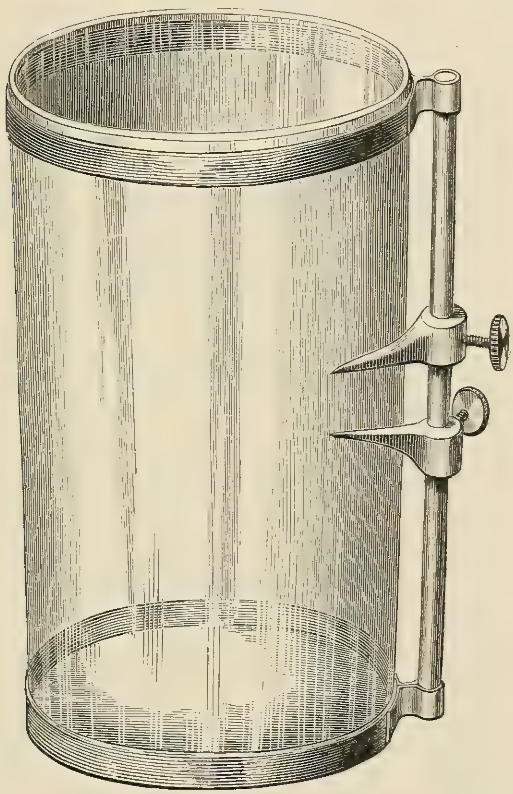
FIG. 119.

brushed off with a jeweler's brush or a soft brush wheel, which will leave the surface of the model with a high polish.

Packing the Mold.—The portion of the flask containing the teeth should be first heated in an oven or furnace, or over the flame of a spirit-lamp, until the temperature of the whole is sufficient to render the rubber soft and pliable as successive portions are applied and pressed into the mold, and to retain it in that condition until the operation of packing is completed. Narrow strips of the rubber should first be worked carefully into the contracted groove underneath the platinum pins with small curved or straight-pointed spear-shaped steel instruments (Fig. 119), adding on small pieces at a time after each successive portion is thoroughly impacted, until the main groove of the matrix over the base of the teeth is partially filled. The palatal convexity of the mold may then be covered with a single piece cut to the form of the uncovered space; a smaller piece of the same general form as the latter may then be added, giving to the central portion a double thickness of the gum-plate material, so that when the two sections of

the flask are brought together, the excess of gum in the center will be forced gradually to the margins of the mold, diminishing, thereby, the liability of the grooves becoming prematurely clogged with the material before the opposing sections of the flask close upon each other. Especial care should be taken in the process of packing to avoid contact of the instruments with the surface of the

FIG. 120.



mold, as fragments of the broken plaster are liable to mix with the gum and render the surface of the finished work imperfect by forming small pits wherever such particles occur.

In regard to the quantity of rubber necessary perfectly to fill the matrix, experience in its use will enable the operator to estimate the capacity of the mold with tolerable accuracy. Some

small *excess* of rubber should always be provided. The required quantity, however, can be more certainly determined by *measurement*. A very simple instrument (Fig. 120), contrived by Dr. E. T. Starr, may be used to determine the quantity by measurement. The vessel being partly filled with water, the lower point is adjusted and fixed with a screw to mark its height. Into this every particle of the trial base-plate is immersed, and the rise of water indicated in the same manner by the upper point. The vessel is then emptied and well cleansed, clean water filled in to the level of the lower point, when rubber is added in sufficient quantity to bring the surface of the water on a level with the upper point; to this is to be added the necessary excess of rubber before recommended.

Having completed the packing of the mold, the two portions of the flask are reapplied to each other in exactly their original relation, being careful that the apposition of the two is such that, when approximated, the guides attached to one division of the flask shall pass directly and without obstruction into the grooves or slots in the one opposite. With the flasks first introduced, some difficulty and uncertainty were experienced in effecting the desired closure of the flask on account of inherent defects of construction, but more recent improvements have entirely obviated this difficulty.

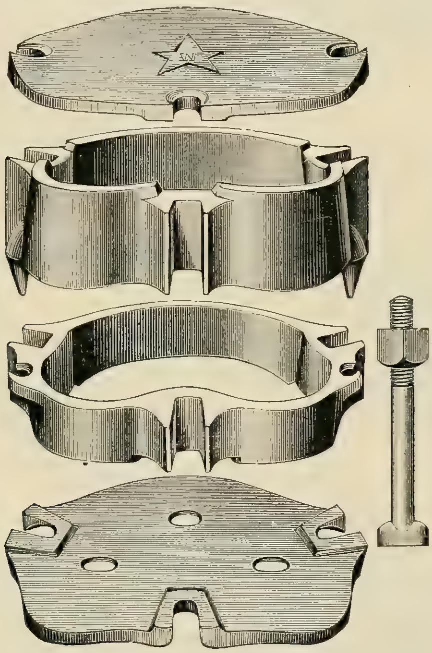
What is known as the "Starr Flask," highly commended as fulfilling very perfectly the requirements of practice, and as happily meeting some important indications, is represented in Fig. 121. Every operator of experience is familiar with the annoyance and difficulty sometimes attending a satisfactory adjustment of models of unusual depth, often of lower sets, and partial pieces, where the porcelain teeth are secured by the surrounding plaster to the model —difficulties arising from the shallowness of the lower section of flasks as ordinarily constructed. The "Reversible Flask," invented by Dr. E. T. Starr, the different parts of which are represented in the accompanying cut, provides very perfectly for any exigency that may arise in the class of cases mentioned. The following description of this flask is taken from the *Dental Cosmos:*

"The rings are of different widths, either of them fitting the top or bottom accurately, as may be required.

"By using the wide ring next to the bottom, an admirable flask is obtained for deep cases and partial sets, or where the artificial

gum rests on the natural. The narrow ring is used next the bottom plate, for whole dentures, where the parting is at the rim of the plate. The bottom has three countersunk holes, through which the plaster runs, and, when set, holds the accompanying ring securely to it. The fastenings of the flask are T-shaped at one end, and fit the slots in the bottom plate; and, being free at both ends, are more easily adjusted than ordinary bolts. The flask being in four pieces (two rings and two plates), the plaster is removed without the usual trouble."

FIG. 121.



The writer has, for several years, used with much satisfaction a flask constructed with detached T-shaped bolts fitting accurately into slots or grooves extending continuously from top to bottom of the flask, as represented in Fig. 122. The closure of the sections by this arrangement, with the bolts in place, is unerring, and is accomplished with the greatest facility. It is known as the "Improved Anchor Flask." Another useful form of flask is that devised by Dr. I. N. Broomell, and is represented in Fig. 123.

Fig. 124 represents an oblong, or "box flask," designed for

FIG. 122.

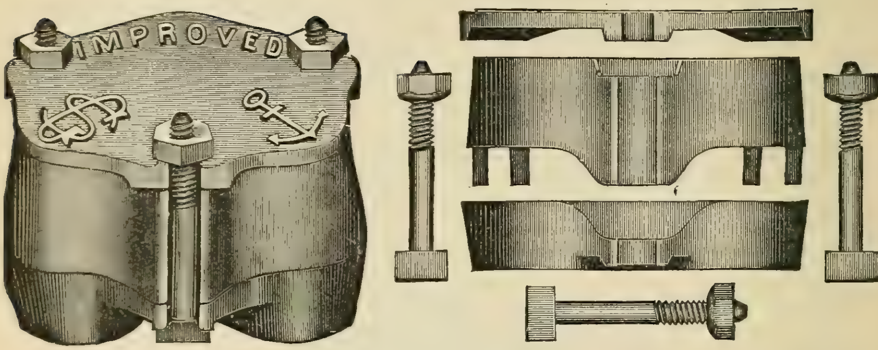


FIG. 123.

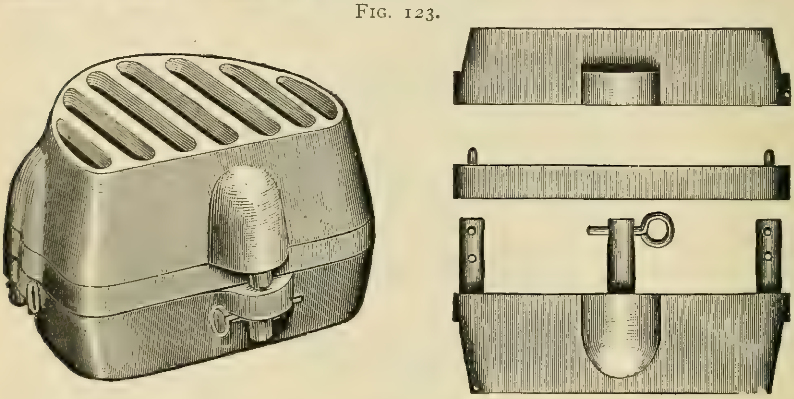
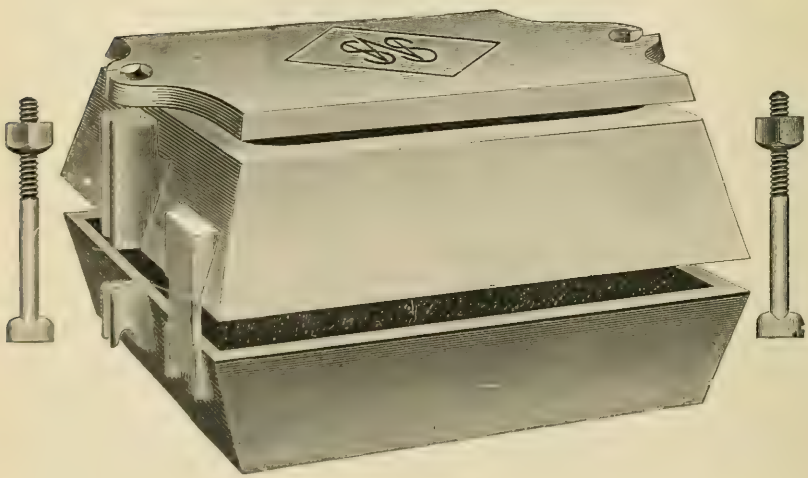


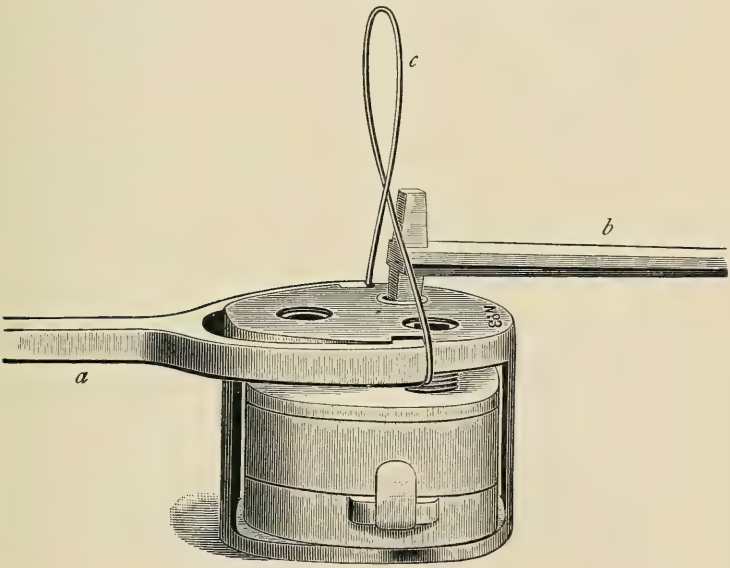
FIG. 124.



exceptionally large cases, splints for fractures, artificial palates, etc.

Whatever flask is used, the entire mass of inclosed rubber should be rendered uniformly plastic, after packing, by subjecting it to either a dry heat, such as may be obtained with a conveniently constructed sheet-iron furnace, the baking apartment of an ordinary cooking stove, or any other available means by which a diffused and uniform temperature may be secured, being careful not to overheat; or, if moist heat is employed, by immersing the flask in boiling

FIG. 125.



water for a time sufficient to soften the rubber. The approximation of the sections of the flask should be effected interruptedly—alternately heating the entire mass and tightening by means of the screw-bolts until all the redundant material is expelled by degrees through the outlets provided for it, and the sections of the flask close accurately upon each other.

The Brown Clamp Flask.—This simple and effective appliance, devised by Dr. Wister P. Brown, is intended principally to do away with all bolts, and to give a more even and ready distribution of pressure in closing the flask. With three screws we may move

the rubber to any portion of the flask desired, which is impossible with a one-screw flask-press. If more space is desired between flask and clamp, the top plate of flask may be removed and turned bottom upward, when the flat surface of the clamp bottom will answer same as top plate. Fig. 125 illustrates this form of flask. The holder (*a*), key (*b*), and a brass wire lifter (*c*), prevent any burning or soiling of hands. Clamps and flasks are made all sizes, so that two of each may go in any two-flask vulcanizer. If the screws of the clamp are kept lubricated with oil, they will last for many years.

Vulcanizing.— The process of vulcanizing or hardening the various rubber compounds employed for dental purposes is effected by subjecting them for variable periods of time to the action of heat, the substances to be acted on being confined within a chamber constructed for the purpose.

As introductory to a consideration of the usual methods and appliances employed in the process of vulcanizing, considerable space is given to the following abstract of a paper by F. Alb. Boeck, of Berlin, Germany, translated by Dr. Louis Ottofy, of Chicago. The discussion embodies a somewhat exhaustive consideration of the *rationale* of the process of vulcanizing, and is introduced in this connection not only as a matter of curious scientific interest, but as of practical importance in the proper treatment of a plastic material which still continues to be largely used as a base for artificial dentures. The writer says:

" The rubber we use, as is well known, is common rubber mixed with sulphur, to which is added certain coloring materials. Of the latter I will speak later in the course of this paper. Though they may influence the hardening of the rubber indirectly, they have no other direct influence. This rubber mixed with sulphur forms our ' dental rubber.' The rubber which we obtain from the dental depots is already ' vulcanized,' as this latter simply means mixing the sulphur. We know that when it is heated it becomes hard. The circumstances under which this takes place leads us to several questions: Is it the heat, or the steam pressure, or the melting of the sulphur, which causes the change in the rubber?

" Formerly, the impression prevailed that the hardening took place from the influence of the steam. In the first vulcanizers the flask stood on a stand in the vulcanizers above the water; but

as once, in 1856, the flask fell into the water, the vulcanizing took place as usual, the mistake was corrected. Later it was found that the process would take place even if the heat was passed through oil or sand, and that the same was the case with glycerin and paraffin. Certainly, under these circumstances, the time of vulcanizing was longer than when steam was used; this circumstance, at that time, however, was of no particular consequence, as it took from three to four hours to vulcanize it by steam. I will return to this difference of time later; suffice it to state here that vulcanizing can take place in the absence of steam.

"It is clear, therefore, that it is the heat alone which causes the hardening of the rubber. In order to answer the question of why this takes place, it will be necessary to turn into the domain of chemistry.

"The rubber is a vegetable product; it is the sap of certain trees, which hardens on exposure to the air. As a vegetable product it is liable to the changes of all other vegetable substances, and all changes which it undergoes are found equally effective on other vegetable substances. From this fact it is very simple to draw conclusions for our purpose.

"Chemistry teaches that all vegetable products, such as wood, starch, the leaves and sap of plants, consist of four elements, oxygen, nitrogen, hydrogen, and carbon. In no plant, or the product of a plant, is carbon absent, and it is mostly in connection with hydrogen and oxygen, whereas nitrogen is but seldom present. From these few elements nature has produced all that earth possesses of vegetable growth, the variety and difference being sometimes only the different proportion of union of the elements, or the addition of a small amount of acids, bitter substances, coloring matters, or salts. Rubber consists only of the above elements, namely, $C_{16}H_7$; it belongs, therefore, to the class known as the hydrocarbons, and to that class of these in which C predominates. It is interesting to notice here that the change from the soft to the hard, as is the case with rubber, is the property of all vegetable products. We know that the change takes place by the application of heat, that hydrogen sulphid (H_2S) is formed, and that the process takes place during the exclusion of air. This process is chemically the same as takes place in the dry distillation of wood, in the changing of wood into coal, and of resin into amber. If wood is

heated in the open air it burns; the same is the case with rubber, only that the latter burns slower on account of its larger percentage of C. If wood is, however, heated in the absence of air, as is the case in making illuminating gas, quite peculiar substances are eliminated from the wood, the illuminating gas, which escapes, and three substances; a watery pyroligneous acid (wood-vinegar), a thick, viscid liquid (wood-tar), and a solid mass (charcoal).

"The wood-tar is, like the rubber, of a resinous nature; it consists of the oil of wood-tar and a liquid substance, burnt resin. Both *become hard on cooling;* the former is the well-known paraffin, the latter the equally well-known pitch.

"The rubber undergoes similar changes. If it is heated while excluded from the air, as is the case in vulcanizing, there escapes (as in the case of wood, illuminating gas), the hydrogen sulphid, and there remains a plastic, which hardens on cooling, as in the case of pitch or paraffin, and we have our hard rubber.

"If we think over this subject, it becomes clear to us why sulphur is added to the rubber. By dry distillation one or more equivalents of hydrogen separate from the mass and remain gaseous, or unite with other substances present and form a liquid, thus leaving behind a hard substance, which consists mainly of C. It is well known that the hardest substance, the diamond, is pure C. The more equivalents of H that remain, the softer is the substance, as in the following scale: coal, resin, pitch, axle grease, oil, ethereal oils, gases. The same is the case in the reversed order. If from the soft rubber hard rubber is to be made, it is necessary to remove from it one or more equivalents of H. This is the case in dry distillation. If there was no dry distillation, if the rubber was heated under free admission of air, the C would immediately unite with the O of the air, forming carbonic acid, combustion would take place, even though it would be slow and difficult. That cannot take place when the air is excluded, the carbon remains unchanged, whereas the H finds a substance with which it is more than willing to unite at a high temperature. This substance is the S, and the union of these forms H_2S, which is well known to us by its odor. When this union has taken place a chemical change has been accomplished, a new substance has been produced, the gas escapes, the remainder, the product of the distillation, contains less H than the raw rubber, and on cooling, like pitch, it becomes a harder

substance by its containing more C than before. Hard rubber, therefore, is one step nearer to resin than soft rubber. All resins are, as is well known, involatile substances, and they possess the power to prevent other substances from becoming volatile; they are insoluble in water, and, consequently, tasteless; they are soluble in volatile oils, as turpentine oil, benzene, etc. It is known that hard rubber does not only possess these characteristics, but resembles the resins, by its easy electrification, to a remarkable degree.

"My hypothesis, therefore, leads me to the following conclusion:

"*The hardening, or so-called vulcanizing of rubber, is the changing of caoutchouc into a resin-resembling substance, by the process of dry distillation; that is, by the removal of one equivalent of* H. *The addition of* S *serves only as a base, which is indifferent toward* C, *but unites with* H *by virtue of a strong chemical affinity existing between* H *and* S, *which form a new compound,* H_2S, *which escapes as a gas.*

"You will notice I do not agree with the opinion that the sulphur, by melting and hardening, exerts the influence required to harden the rubber. The hypothesis was laid down in some American dental journal, that just as is the case with camphor and celluloid, it is with sulphur and rubber; that is, that the sulphur is the medium which brings the particles of rubber into the plastic condition, and afterward retains them in the hardened condition.

"We know that a portion of the original composition of the rubber has disappeared, and we know that some of the sulphur and hydrogen disappear. It is natural that if more sulphur is present than can combine with one equivalent of hydrogen, the remainder is in mechanical union with the rubber. If hard rubber be heated to a degree somewhat higher than the boiling-point of water, it loses its hardness. This fact might lead to the conclusion that the sulphur melts, and thus influences the hardness of the rubber. If, however, the correctness of my theory be granted—that is, that hard rubber is nothing but the resinous state of the original product—we observe that it must soften, as the melting-point of the resins is about the same as that of sulphur. Furthermore, we know that sulphur hardens slowly, whereas resins become hard more rapidly, as is the case with shellac and sealing-wax; the same is the case with heated hard rubber. Hard rubber, when undergoing the change from its melted condition into the hard

condition, does not change the character of its molecular relation, remaining amorphous; resembling in its structural appearance molten glass. All resins, gum, glue, tar, etc., show the same characteristics. Sulphur, on the contrary, when changing from its molten condition, either crystallizes or becomes crystalline in appearance.

"I do not wish to prove anything further by this theory. It may, however, be mentioned, that if it be correct, some important results may be accomplished. I will mention, for one, the fact that the scraps and filings of hard rubber, which are now useless and thrown away, may be made valuable and useful. Lately, a patent has been obtained by which useless vulcanized rubber may be made useful.

"Leaving this subject, we now arrive at one not less important, namely, the influence of steam pressure on vulcanization.

"It has been previously stated that vulcanized rubber may be hardened without steam. This teaches us that hardening is not produced by steam. The theory which has been discussed gives us the reason. The question arises, why do we use steam? The answer is, steam has no direct influence in vulcanizing; it only serves, the same as oil, sand, paraffin, or glycerin, for the transmission of the heat. This takes place by use of steam, faster and with more precision and certainty than with other substances. Furthermore, it will be shown further on that for other reasons steam is the best vehicle for the purpose.

"As with oil, by using steam the heat is equally distributed and the temperature rises evenly. Changes of temperature, as is the case in dry vulcanization or overheated steam, are also prevented. It also has the important advantage of causing the hardening to take place more rapidly. This latter fact is known to us by experience; it only remains to explain the reason why this is so.

"By the use of steam, hardening takes place in from fifteen to seventy-five minutes, according to the temperature, the quality of the rubber and its thickness; by the use of dry heat or oil the process requires from two to three hours, and the requisite degree of heat must be reached gradually. What is the reason that by use of steam and a high degree of heat it takes less time to vulcanize? It must be remembered that the higher the tempera-

ture, the less time is required to vulcanize. The reason of this is clear, if we remember that, according to my theory, hardening is subservient to the escape of a certain amount of hydrogen from the rubber.

"The greater the heat, the easier is the separation of the unnatural union, as it were, of the hydrogen with the carbon of the rubber, and it also facilitates the union of this H with the S, which is in a molten condition. This takes place in accordance with the laws of chemical affinity and relation. It is a sort of magnetic power which the sulphur exerts upon the hydrogen, and which becomes firmer and more powerful the higher the temperature. Here the steam does not take any part, as it only does the same thing that oil or sand would do, and that is to transmit the heat. There must be another reason why the use of steam permits us to increase the temperature and shorten the time. We know that we cannot do so when using sand or oil, as in that case the rubber becomes porous. If we can find the reason why the rubber becomes porous, we can ascertain the influence of the steam when used a shorter time.

"A great deal has been written and said in regard to the porosity of rubber. This takes place when the escape of the gas is retarded or prevented in certain places. This may take place when the heat was applied rapidly or unevenly, or when it was not equally distributed to all parts of the rubber. In the latter case, such parts as are more exposed to the radiating heat than others become hard much sooner, because the H escapes quicker. In the former case, that is, by rapid increase of heat, the outer surface of the rubber hardens sooner than the inner, to which the heat only reaches gradually. Rubber is, as is well known, the poorest of conductors. It is clear, therefore, that the thicker a piece is, the longer it takes it to become heated in all parts, and the more gradual must be the heating, in order that an even hardening, or rather an even drying, of the mass may take place, so as not to produce a hardened outer rim when the inner substance is yet soft, *i. e.*, contains more H. The H, which is becoming rarefied by the increase of heat, has not the power to force itself through the hardened parts; it, however, possesses a considerable power of expansion, which increases by the constant application of heat; it

therefore forms a cavity for itself in which the yet unhardened rubber deposits its H as long as it escapes from the rubber, and until it is free from it and becomes hard. This is a supposition which becomes more clear by future statements.

"Accordingly, in order to prevent porosity, nothing else is necessary than to heat it in such a manner that the heat is equally distributed. This result is obtained by observing:

"1. That the heat is equal on all surfaces, and

"2. That the heat be gradually raised and continued, according to the thickness of the plate.

"In making plates of considerable thickness, experience taught us to observe the above rules, or the strength would be lessened.

"It was mentioned before that steam, like oil or paraffin, serves simply to convey the heat. It furthermore possesses two other properties which make it more valuable than the other substances: 1. Its well-known property of conducting heat. 2. Its elasticity. In consequence of its conductibility, it distributes the heat evenly; and in consequence of its elasticity, it prevents an uneven rise of its temperature, while oil, *e. g.*, will follow any change in the temperature that may be caused by the applied heat. Consequently, steam serves as a reservoir of heat, as a balance-wheel serves as a reservoir of power; as the latter distributes the force, so does steam distribute evenly the over-abundance of heat from one point where the flame is larger, or for a moment when the heat is greater it is equalized over the surface and over several minutes of time. Therefore, if the rubber exposed to it is not too thick, so that its influence can reach through the whole mass of the poorly conducting rubber, one may be certain that by the use of steam the heat exerts its influence evenly and the temperature also rises equally. There need be no fear, therefore, that one place will be harder than another, as is often the case with oil; also the temperature may be raised higher, and, consequently, less time required for the process, and no fear entertained on account of porosity.

"Another property of steam may here be considered which exerts a still greater influence than either its conductibility or elasticity, and which also hastens the process I have illustrated, chemical affinity; viz., the magnetic—that is, the power of substances to form certain compounds.

"The steam acts like a magnet upon the sulphureted hydrogen, dissolving this gas with a great deal of alacrity, forming a solution of sulphureted hydrogen.

"It is true that the property of steam is contradictory to the formation of H_2S within the rubber. The hardening, in my opinion, is nothing more than dry distillation, and this is nothing more than 'slow burning by the exclusion of air.' This takes place more rapidly the better the provisions are for carrying away the products of combustion, such as carbonic acid, oxid of carbon, etc., and the same is the case in any chemical change.

"What the chimney is in the burning of wood, the steam is in vulcanization. In the latter, the product—that is, the H_2S—is readily taken up by the steam, thus furnishing the opportunity for more to be formed, and permitting the rubber to harden quickly. This is the main reason why we can vulcanize faster when using steam than either oil or sand.

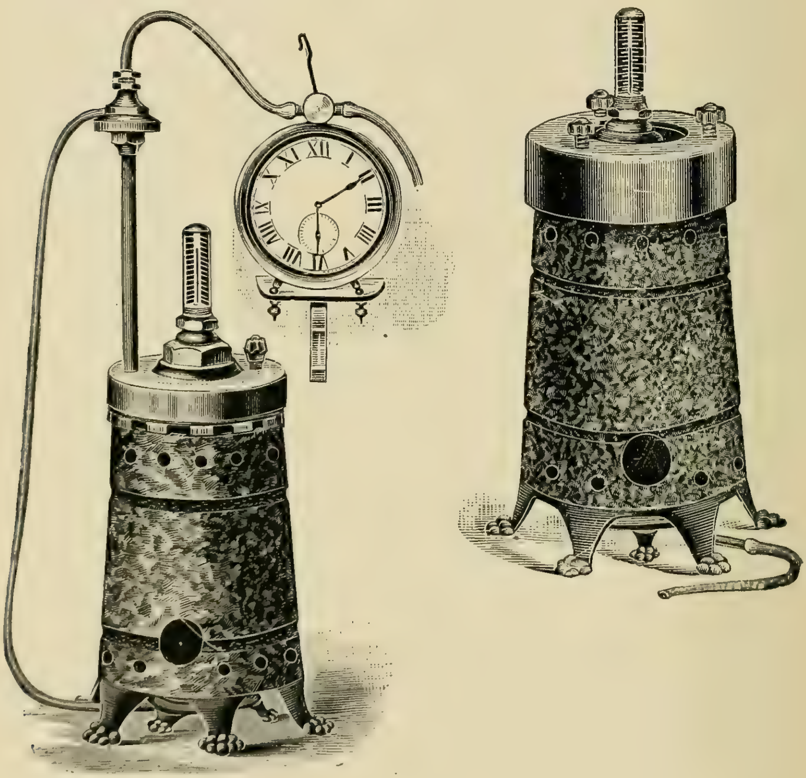
"The other properties of steam permit of raising the temperature rapidly, and by absorbing the gas which is formed, serve as a proof of the foregoing assertion, that the hardening of rubber takes place by the escape of one equivalent of H_2, and that porosity is caused by hindering the escape of this gas."

The Time and Temperature Necessary.—As solid fuel is no longer employed in vulcanizing, any description of the apparatus especially adapted to this mode of producing heat is deemed unnecessary. They have been entirely superseded by others of improved form and construction adapted to the use of either gas, alcohol, or coal-oil and its products, for heating purposes. After the lamp or burner has been lighted, it should be so regulated as to require a *half hour to raise the temperature to the vulcanizing-point,* 320° F., or 120 tbs. pressure by steam-gage. This, of course, is for ordinary work; where for any reason the rubber is unusually thick the time for running it up to the vulcanizing-point should be extended to one hour or more, according to the thickness of the mass, as *the heat, if run up too rapidly, will cause the rubber to become spongy or porous.*

Fig. 117 represents the Hayes vulcanizer with capacity for from one to three cases. The iron-clad improvement in these machines is designed as a protection from the dangers of explosion consequent upon a gradual thinning of the copper boiler from corrosion,

a safeguard of great practical value and concern to those who are continually exposed to the perils of such an accident. The shell is made of malleable iron, 1/8 of an inch thick, strong enough to resist many times the strain required, and can never be exposed to deterioration. The copper lining is made the same thickness as the copper boilers now in use, and the machine may be used with

FIG. 126.



perfect safety, even when the copper has become as thin as paper; and then, when an opening has been fairly eaten through, steam will escape from between it and the iron shell, below the packing joint, giving timely notice that a new lining is required, which can be inserted at moderate expense, and render the vessel good, and safe as new.

A peculiar and important feature of these vulcanizers is in placing

the thermometer bulb within a mercury bath, outside the steam-chamber, relieving it entirely from the danger of being crushed or checked by the pressure of steam, as is liable to happen when it is exposed to the steam itself, necessitating its frequent replacement.

In the accompanying illustration the time and gas regulator is also shown. This regulator (the Coolidge-Lewis) is without doubt the most convenient and perfect in its action and adjustment of any yet constructed.

The pointer is so constructed that it acts as a stop by coming in contact with the inlet tube. This stop prevents the regulator from being set either by design or accident to maintain a higher temperature than the highest graduation on the base, and endangering the safety of the vulcanizer. It also requires no special adjustment after leaving the factory.

To vulcanize at any of the degrees of temperature marked on the graduated base, all that is required is to turn the milled hand-plate till the pointer is over the degree desired. This can be done either before or after lighting the gas under the vulcanizer.

It should not be forgotten when vulcanizing at a low heat to extend the time of vulcanization.

Better results are obtained by running the vulcanizer from an hour and a half to two hours—exclusive of the time of heating up —at a low heat.

This graduated gas regulator is provided with a by-pass screw adjustable to different pressures of gas. The adjustment, as it leaves the factory, is for coal gas—low pressure. If the regulator is to be used with natural gas, at a high pressure, too much gas will be passed after the proper temperature has been reached. A readjustment of the by-pass will then be required. This is accomplished by turning the small screw on the side of the gas-chamber till the flame maintains the heat at the proper temperature. Fuller instructions accompany these regulators when sold to the profession.

The Whitney Vulcanizer.—A not less convenient, safe, and reliable vulcanizer is that known as Dr. Whitney's, represented in Fig. 127, having a steam-chamber capacity for from one to three flasks.

The Mann Vulcanizer is shown in Figs. 128 and 129. The

FIG. 127.

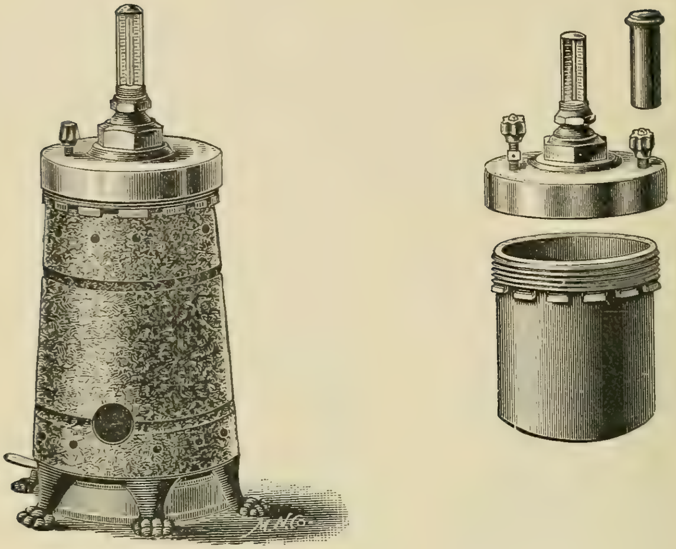


FIG. 128.

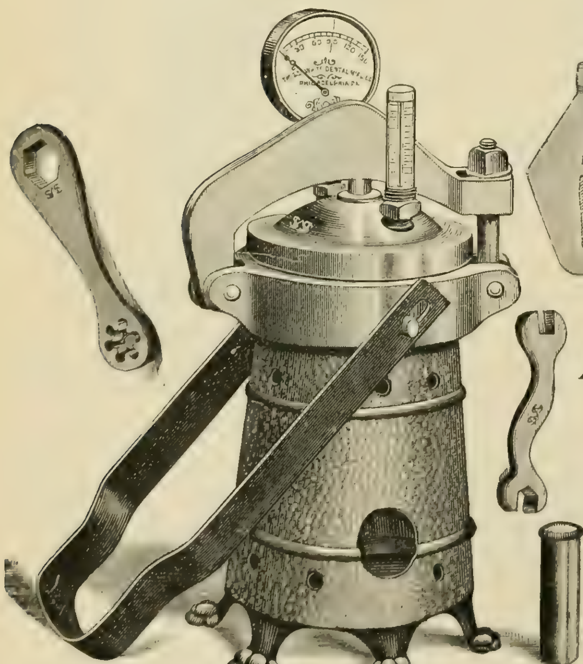
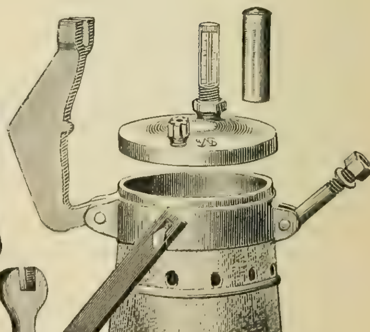


FIG. 129.



same apparatus has stove attachment for the use of kerosene, and admits of the use of thermometer or steam-gage.

The facility with which this vulcanizer may be operated is one of its distinctive features. The lid, instead of being screwed on to the boiler, is fitted neatly, and rests on a shoulder formed on the casting, and is secured by a heavy steel clamping-bar and screw-bolt. One end of the bar is hinged to the side of the boiler, the outer end being slotted to receive the screw-bolt, which is hinged to the other side of the boiler. Rubber packing between the lid and the shoulder on which it rests makes the joint steam-tight. The lid is removed by unscrewing the nut of the screw-bolt a turn or two, when the bolt drops out of the slot and the bar is turned back, leaving the lid free to be removed. This method, while it gives as perfect a fastening as the usual plan, affords very much greater facility for opening and closing the boiler. Should it stick, by reason of the packing becoming chilled (a common occurrence with all vulcanizers), it is pried off with very much less trouble than is required when the top screws on.

Another advantage is the bail, a simple but heretofore unthought-of device, which greatly facilitates the handling of the vulcanizer, especially when hot. Thus the boiler can be opened for the removal of one case and the placing of another. The nut of the clamping-bolt is loosened a little at a time, allowing the steam to escape gradually until the bolt is released, when the bar can be thrown back and the top of the boiler raised. The bail is also useful in removing the boiler from the jacket, in tightening or loosening the screw-bolt when closing or opening the boiler, and at all times when the boiler is to be lifted. When not in use it is readily removed.

The Boston Vulcanizer.—This vulcanizer, manufactured by the Boston Dental Manufacturing Co., is made of the best bronze, so-called "gun-metal," and is tested at 1000 pounds hydraulic pressure. It will hold three flasks, and allow plenty of room for handling. The packing is molded instead of being cut in strips, and it is claimed will last for years without being renewed. The cover can be screwed steam-tight without the use of a wrench, the same being necessary only to open after being heated. The small quantity of water used (one gill) produces vulcanizing by steam, instead of water, thus giving better results.

The bed-plate jacket, which is screwed to the bench, allows an easy and ready method of handling. It is illustrated in Fig. 130.

The Philadelphia Vulcanizer.—The several parts of this vulcanizer are illustrated in Fig. 131. Its simplicity is shown in A, B, and C. A represents the copper bowl; B, the ring or socket

Fig. 130.

with an annular rib on the top, which supports the copper bowl, while C shows the tripod yoke or lid. There are no bolts, nuts, wrench, nor bed-plate required, making it altogether the simplest and one of the most convenient vulcanizers extant.

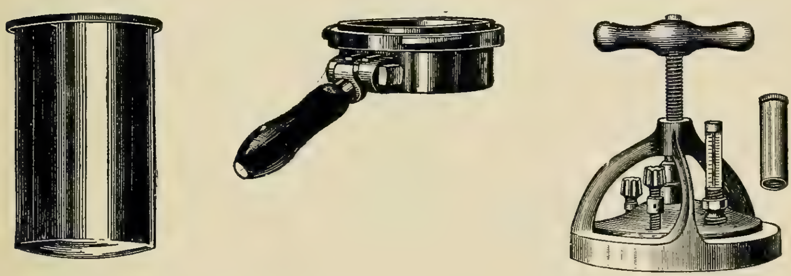
In vulcanizing, the heat should be maintained at 320° for about one hour and ten or twenty minutes. Vulcanization may be effected

at a lower heat, but the time must be proportionately extended; or a higher heat being employed, a less time will be required to vulcanize. Care should be taken, however, not to overheat, as the rubber is thereby rendered dark and brittle, and the important property of elasticity impaired. The time and degrees of heat mentioned, therefore, may be regarded as the safest, and as yielding the best results, though with other rubber compounds, and the use of modified forms of vulcanizers, corresponding differences in time and temperature may be required, and which can only be accurately determined by vulcanizing test-pieces of rubber.

In this connection the reader's attention is called to some practical observations on the subject of steam pressure in vulcanizing,

FIG. 131.

A B C



and the reliability of thermometers as indicators of heat, and which acquire additional interest if it be true, as alleged, that many of the vulcanizers in use by dentists are insecure by reason of inherent defects of construction or faultiness in the modes of indicating the elastic force of steam. In commenting on this subject the late Prof. Wildman observes:

"As high steam is used in vulcanizing, it is important that the operator should be conversant with the nature of the agent which he employs to accomplish this end. It is perfectly safe; but the following will show him that it must be used with discretion and judgment. Numerous experiments have been made by scientific men to ascertain the elastic force of steam at different temperatures. The results of their investigations are not uniform, although they all agree in showing the immense force exerted by this agent at high

temperatures. Haswell's tables are looked upon as good authority. The results of the investigations of the Franklin Institute Committee, in the higher degrees, give a greater elastic force than the table below quoted. I shall, however, quote the results of the experiments of the commission of the French Academy, appointed by the French government to investigate this subject, for the reasons that, from the manner in which they were conducted, they are probably as reliable as any, and that they are extended to a more elevated temperature than the others.

Elasticity of steam, taking atmospheric pressure as unity.	*Temperature F.*	*Pressure, per square inch, pounds.*
1	212°	14.7
1½	233.96°	22.05
2	250.52°	29.4
2½	263.84°	36.75
3	275.18°	44.1
3½	285.08°	51.45
4	293.72°	58.8
4½	300.28°	66.15
5	307.05°	73.5
5½	314.24°	80.85
6	320.36°	88.2
6½	326.26°	95.55
7	331.70°	102.9
7½	336.86°	110.85
8	341.78°	117.6
9	350.78°	132.3
10	358.88°	147
11	366.85°	161.7
12	374.00°	176.4
13	380.66°	191.1
14	386.94°	205.8
15	392.86°	220.5
16	398.48°	235.2
17	403.82°	249.9
18	408.92°	264.6
19	413.78°	279.3
20	418.46°	294

"I would here call the attention of those using high steam to an important consideration. In raising steam, *the ratio of increase of pressure or elastic force is far greater than that of the increase of temperature.*

"By referring to the above table, commencing at 212° and tak-

ing steps as near 50° as is given in the ascending scale, we find this exemplified. Thus:

Increase of temperature.	*Increase of force per square inch.*	*Giving a force per square inch.*
From 212° to 263.84° = 51.85°	22.05 lbs.	36.75 lbs.
" 263.84° to 314.24° = 50.40°	44.10 lbs.	80.85 lbs.
" 314.24° to 366.85° = 52.61°	80.85 lbs.	161.85 lbs.
" 366.85° to 418.46° = 51.61°	132.15 lbs.	294 lbs.

"This comparison shows clearly how rapidly the pressure increases at high temperatures, and warns the operator that a strong instrument, combined with care and judgment in its treatment, are indispensable to safety. Besides the rapid increase of pressure, it must be borne in mind that at high temperatures, copper, of which the boiler is composed, becomes weakened, and in a measure loses its power to resist this great imprisoned force. Copper, in passing from 212° to 230° F., loses about one-tenth of its strength, and at 550° it has lost one-fourth of its tenacity."

In a paper read before the Massachusetts Dental Association, January, 1865, Dr. A. Lawrence affirms that: "Most vulcanizers are now made of sheet-copper $\frac{1}{16}$ of an inch in thickness, and, agreeably to the foregoing facts, have a tensile strength of 1875 pounds; and one four inches in diameter will not sustain a pressure of more than 150 pounds per square inch, or a temperature of 363°.

"Let us next ascertain what force of steam is exerted upon the boiler within a short range of temperatures. We find by the tables of Haswell, King, and others, that at 320° the pressure is 85 pounds; at 324°, 90 pounds; at 328°, 95 pounds; and at 332° it is 100 pounds per square inch. These figures I have verified by a steam-gage connected with my own vulcanizer, and which I now use in preference to a thermometer, as I consider it more convenient, safer, and less liable to accidents.

"Practical engineers concur in the opinion that a force of not over one-half the sustaining capacity of the boiler can be safely applied."

Thermometers as Indicators of Heat.—Immediately connected with the process of vulcanizing is the question of the reliability of thermometers as *indicators* of heat or steam pressure. Dr. Lawrence, commenting on this subject, says: "Suppose the bulb

of the thermometer gets slightly fractured, and, the accident not being discovered, the vulcanizer is put to use, what then?

"If the damage is slight, the mercury may still be made to rise in the tube at high temperatures, but will not truly indicate the full heat or force within. Some time ago I had some difficulty in producing a desirable shade in my vulcanite work; it was too dark, as is the case when overheated, and I came to the conclusion that the gum had deteriorated in quality. Other samples of gum were tried, and at varying lengths of time, yet with the same result.

"No defect could be discovered in the thermometer by the naked eye, but a microscope revealed a slight crack in the bulb, and the mystery was solved. But what force of steam was produced during these almost despondent trials?

"Although my vulcanizer would safely bear a pressure of 100 pounds per square inch, I concluded to use a steam-gage for the future, and now feel a security in its use positively refreshing."

The unreliability of thermometers in connection with vulcanizers has been recognized by many in the profession who have testified to their uncertainty and insecurity as a means of determining with exactness at all times the amount of steam pressure employed in the process of vulcanizing at a high heat.

The steam-gage spoken of by Dr. Lawrence seems very perfectly to fulfil the requirements of the dentist, and may justly claim favorable consideration from the commendation bestowed upon it by the distinguished gentleman who has brought it to the notice of the profession. It is shown in Fig. 128. The following is the author's own account of the instrument: "The gage most suitable for the purpose in question somewhat resembles a small, circular clock, is about six inches in diameter, and marked to register 140 or 180 pounds pressure, with pound dots near the outer circle of the dial. A pointer indicates the force which moves it.

"This size is better than a smaller one, because the spring inside, not being crowded to its utmost capacity in vulcanizing, will, of course, retain its working integrity longer; in fact, as long as any dentist now living will be personally interested in the matter. They can be used with all vulcanizers generating steam, connecting by means of three or four feet, or as much more as may be convenient, of small pipe having a U-shaped bend, or a single coil near and

under the gage to receive the condensed steam, as water alone should enter this instrument.

"The following table exhibits a range of pressure sufficient for vulcanizing purposes, with the temperature necessary to produce the same:

Pressure in lbs.	*Temperature.*	*Pressure in lbs.*	*Temperature.*	*Pressure in lbs.*	*Temperature.*	*Pressure in lbs.*	*Temperature.*
60	295°	69	305°	78	314°	95	328°
61	296°	70	306°	79	314°	100	332°
62	298°	71	307°	80	315°	105	335°
63	299°	72	308°	81	316°	110	339°
64	300°	73	309°	82	317°	115	342°
65	301°	74	310°	83	318°	120	345°
66	302°	75	311°	84	319°	125	349°
67	303°	76	312°	85	320°	130	352°
68	304°	77	313°	90	324°		

"It will readily be seen by the above that a pressure of 60 pounds requires a temperature of 295° by Fahrenheit's scale to produce it, and 85 pounds 320°, at which latter pressure I vulcanize, running one hour, and with the most satisfactory results."

Removing the Flask after Vulcanizing.—When the process of vulcanizing has been conducted a sufficient length of time, the flame is turned off and the steam discharged through the safety-valve, if the vulcanizer is provided with one; or the lower half of the boiler may be placed in cold water until the contents are cooled down to about 200°. When time will permit, however, it is better to let the vulcanizer cool gradually. The top is then taken off and the flasks removed. The latter should always be allowed to cool gradually, as the immersion of the flask, while hot, in cold water will endanger the porcelain teeth by a too sudden change of temperature. Neither should the flask be opened while hot, for the plate, being pliable when heated, would be liable to suffer some change of form in forcing the sections of the flask apart, or in removing the piece after separation of the flask. When the plate is removed from the flask, detach carefully all adhering plaster with a pointed knife, and cleanse well by washing with a stiff brush.

The Finishing Process.—The rougher and more redundant portions of the rubber are first removed with coarse files or rasps, following with those of a finer cut (Fig. 132) or lathe burs (Fig. 134), until all parts of the piece accessible to such instruments are

reduced to nearly the thickness required. The excess of material

FIG. 132.

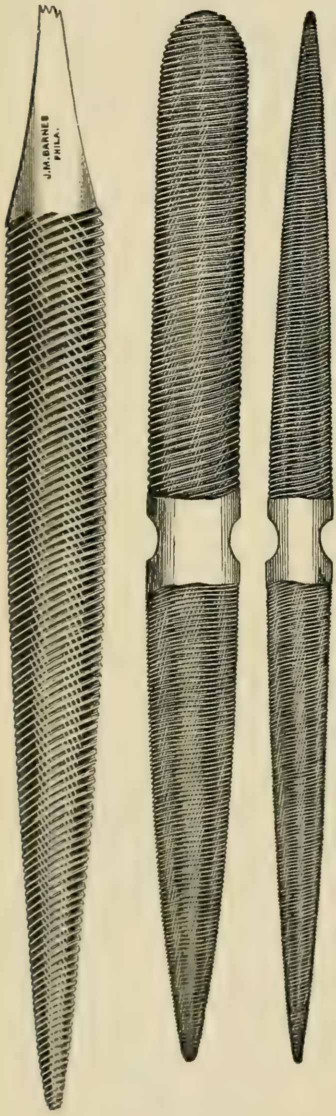


FIG. 133.

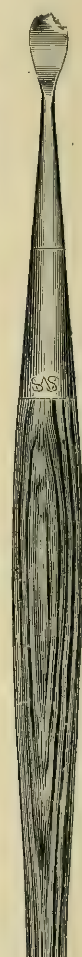


FIG. 134.

on the lingual side of the plate and other points not admitting of the use of the file is removed with scrapers of various forms, some

of which are shown in Fig. 133. After nearly the desired thickness is thus obtained, and the surface rendered somewhat smooth and uniform, a still further reduction is obtained with the use of sand-paper, using first the coarser and finishing with the finer numbers. The final polish is then given to the surface, first with the use of finely-pulverized pumice-stone, and afterward with either prepared chalk or whiting. The best method of applying the pumice is with flat, circular pieces of cork of various sizes, which may be readily formed by attaching them to the lathe and reducing them to the proper size and shape with a file while revolving. The chalk or whiting may be applied upon a cotton or ordinary brush wheel. In the use of the polishing materials, the latter should be kept constantly and freely saturated with cold water throughout the operation.

Partial Dentures Constructed on a Base of Rubber.—The foregoing description of the method of forming entire dentures on a base of rubber, together with a knowledge of the manner of constructing parts of sets of teeth mounted on metallic plates, will render any extended description of the former process, as it relates to partial pieces, unnecessary. A base-plate of the required thickness and dimensions is accurately adapted to a model of the parts, the narrower portions passing into the spaces between the teeth being stiffened by doubling the plate at these points with an additional strip of the material used. The central portion of the plate may also be temporarily supported, and its form preserved, by filling in the concavity with a layer of stiffened wax. A rim of wax is then attached in the usual manner to those portions of the plate occupying the vacuities on the ridge, when the plate is placed in the mouth and an impression of the points of the opposing teeth secured; it is then removed, reapplied to the model, and the heel of the latter extended posteriorly to form an articulating surface for the remaining portion of the antagonizing model—the latter being formed in the ordinary way. The teeth are then fitted to the vacuities in precisely the same manner as when metallic plates are used, and the wax trimmed to the required fullness. The plate, with the teeth attached, is then placed in the mouth and any necessary corrections made in the arrangement of the teeth; after which it is removed and readjusted.

In constructing partial sets of vulcanite, it is of the first im-

portance, when forming the mold, that the relation of the porcelain teeth to the model of the mouth should be accurately maintained, the reasons for which are fully set forth when treating of the formation of the mold or matrix for full sets. To secure this result with certainty the following method should be adopted. Having adjusted the plate and teeth upon the model, with the wax trimmed and carved to the required fullness, place the model in the lower section of the flask and fill in with plaster, extending it up to the points of the teeth, binding them to the model, and making the line of separation of the sections of the flask at that point. The ends of the plaster teeth should be cut away sufficiently to allow of a ready separation of the sections. Plaster is then poured in for the upper section of the mold, and, when hard, the flask is parted and the wax removed from the model and teeth, the latter being retained in the lower instead of the upper section as in full cases.

Metallic Clasps Attached to Rubber Plates.—Although at-

FIG. 135.

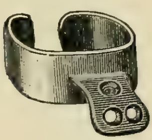
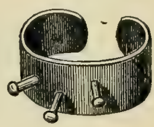


FIG. 136.



mospheric pressure or adhesion should be made available in all practicable cases as a means of retaining parts of sets of teeth in the mouth, yet cases frequently present themselves necessitating the employment of clasps. These may be of rubber, but those formed of gold, or gold alloyed with platinum, are more reliable and better adapted to those cases where the spaces between the teeth are contracted.

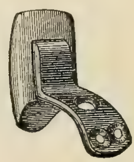
In constructing a clasp, first bend the clasp to fit the tooth accurately; then make the attachment by which it is to be held to the rubber (this may be done by soldering a thin plate of gold or platina to the clasp in such a position that it will be inclosed in the rubber); then perforate the plate with numerous small holes, which should be countersunk on both sides (Fig. 135). This plate entering the base, the rubber filling the holes forms pins which rivet the clasp securely to the rubber plate.

Or the attachment may be made in this manner: On the parts

of the clasp that can be covered with rubber drill one, two, or three holes, as the space may admit; insert gold or platina wire, solder with gold solder, then cut off at proper length, and head them (Fig. 136); these act in retaining the clasp in the same manner as the double-headed pins in securing the tooth to the base, and offer the advantage over the perforated plate of being more easily manipulated and less liable to become displaced in packing the mold. The clasp is to be attached to the model plate, and will remain secured in the mold when it is opened.

Substitution of Plate for Rubber Teeth.—An ordinary plate tooth, such as is commonly used in connection with a metallic plate-base, can be readily rendered suitable for a rubber base. This is done by soldering a narrow strip of gold plate to the ends of the platinum pins, forming a loop or staple, and which, imbedded in the rubber, renders the attachment very secure. A narrow arm of rubber extending to a single tooth may be materially strengthened by placing a metallic backing on the tooth and permitting the gold strip, perforated with holes or roughened on its edges, to pass some distance into the rubber, as seen in Fig. 137. This method may be resorted to with signal advantage in cases of very close bite; that is, where, on closure of the jaws, the points of the opposing teeth encroach unduly upon the space to be filled, extending nearly to the gum, requiring the tooth of replacement to be as thinly formed throughout its length as possible.

FIG. 137.



Repairing.—If a tooth or block has been broken, or any change is to be made in the position of either, the teeth or fragments thereof are removed, and an irregularly shaped groove or dovetail formed in the base occupying the space to be supplied; into this space the tooth or teeth are properly arranged and supported with wax; the dovetail is then filled in with wax, giving some additional fullness to compensate for waste in finishing. All portions of the piece except the lingual face of the plate and teeth are then imbedded in plaster in the lower section of the flask. The upper section of the mold is obtained in the usual way. When separated and all traces of wax removed, the gum is packed into the cavity around the tooth or teeth. Grooves are then cut extending out from the mold, the two sections heated and forced

together, and the process of vulcanizing conducted in the usual manner, the same time and degrees of heat being required as in the first instance. The renewed heat employed renders the surface of the material previously vulcanized somewhat darker, to remove which it is recommended to moisten the surface with dilute nitric acid for a short time, after which the piece is thoroughly washed, and then placed for a few minutes in an alkaline solution to remove any remaining traces of acid. It is also recommended to immerse the case in alcohol for five or six hours, and then expose it to the rays of the sun for a like period of time.

Dr. A. A. Blount, of Geneva, Switzerland, in the *Ohio State Journal,* suggests the following method of replacing a broken crown without removing the entire section: "Finding it impossible to match the injured block," he says, "I ground the broken tooth down to the gum, as one would for a pivot tooth, and, as I had often done before in mending a continuous-gum piece, selecting a plain rubber tooth the exact size and shape, ground it carefully and accurately to fit, cementing it in place with a plastic cement, which served to hold it firm and prevent the rubber from coming through to the front. The plate being prepared as usual for mending, the piece was vulcanized. After being finished, no one could tell that the block had ever been fractured. This method of repairing broken blocks, mounted upon Watt's metal, will be found very practical, as it is somewhat difficult to replace a broken block upon that base."

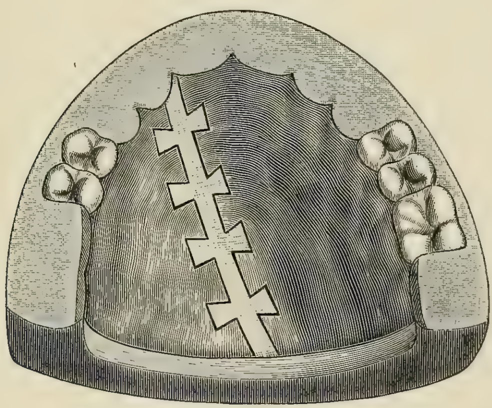
One of the most frequent repairs we are called upon to make is a fracture through the center of an upper partial denture, the break extending from the region of the central incisors backward. The method of repair in such cases is quite simple, consisting in first accurately adjusting the two parts of the plate and fastening them in their correct relation to each other with adhesive wax or shellac. This should be dropped over the entire length of the crack by an assistant, while the sections of the plate are being held in correct apposition. Plaster is then mixed and poured into the plate, forming a cast of the palatine surface of the mouth. After this hardens sufficiently, the wax or shellac is removed, which permits the sections of the plate to be taken up separately. The line of the fracture is now cut out or enlarged upon either side with a large bur revolved by the dental engine, or it may be

accomplished with a file or saw. Dovetails are then cut on either side with a jeweler's saw, and the sections replaced upon the cast. The work at this stage is shown in Fig. 138.

The opening between the two halves and the dovetailed spaces are then covered with wax, the case invested in a flask in the usual way, the flask reopened, and wax removed. The space between the two halves, with the dovetailed spaces, are then carefully packed with rubber, when it is vulcanized and finished in the usual way.

The whole subject of repairing rubber plates is so fully and clearly described by Dr. George B. Snow, in an article entitled, "Repairing Vulcanite Plates," that his processes are here given in

Fig. 138.



detail. The writer would premise that he has long since abandoned the older method of "under cutting" in repairing rubber plates, and would emphasize what is stated by Dr. Snow, "that perfect union can be obtained in such cases if the surfaces of contact are freshly cut, absolutely clean, and properly roughened.

"It is not unusual to see vulcanite plates which have been cracked or broken, and repaired by what may be termed the 'hole and plaster' system. Holes are drilled through the plate along the edges of the crack, and a new thickness of rubber superimposed upon a mass which, possibly, is already too thick for comfort or convenience, the old crack still remaining as a weak point to occasion further breakage. No advantage was taken of any possibility

of union between the old and new material, the dentist having been obviously ignorant of the fact that perfect union can be obtained in such cases if the surfaces of contact are freshly cut, absolutely clean, and properly roughened.

"The great point to be remembered in repairing or making any addition to a vulcanite plate is that the new and old material will unite perfectly, and with such firm adhesion that the plate will be practically as good as new, if the surfaces of the old plate where union with the new material is desired are freshly filed, *absolutely clean,* properly roughened, and of sufficient area. To insure these results, wax should not be melted upon the surfaces of union in waxing up, and removal of the wax from the mold should be accomplished by means of instruments, and not by hot water, unless, possibly, for the removal of very small particles which cannot otherwise be gotten rid of. Any amount of the old material desired may be cut away, and its place supplied by new; and thus any change wished may be effected. In case of breakage or cracking, the plate should be cut away so that the old defects will be wholly obliterated and new material supplied.

"As a first instance, suppose a partial lower plate, supplying the loss of the bicuspids and molars on both sides of the mouth, to be broken through the bar which extends from one side of the mouth to the other behind the incisors. The fracture is generally a clean one, resembling that of glass or porcelain, and the two pieces may be brought into apposition with certainty. The dentist holding the parts together in exactly the right position, the assistant covers the lingual side of the plate at the point of fracture with a few drops of hot shellac from a shellac stick. A little cold water follows, and the two parts of the plate are firmly cemented together. A brace is now extended across from the molars on one side to those on the other, by laying a burnt match on the grinding surfaces of the respective teeth, and fastening both ends with a few drops of hot wax. By this means sufficient strength is obtained to allow of the plate being safely handled. A piece of paper or sheet-wax is cut to fit and reach across the lingual space at the lower edge of the plate, and fastened therein with wax, a coat of shellac varnish is applied to the paper, the surface lathered with soap-suds, and rinsed, and a model run in the same manner as in filling an impression.

" After this has hardened, the plate is removed from the model, which is then given a coating of liquid silex. This is always preferably done in repairing plates, at the time when the plate is first removed from the model. The rubber bar may now be cut away, on either side of the fracture, by a jeweler's saw, the cut being made diagonally, so as to make what is termed a ' scarf ' joint. The surfaces should be further roughened by making a series of shallow parallel cuts across them with the saw, a thick separating file, or a thin wheel-bur. The parts of the plate are then placed upon the model, waxed up, and flasked, the model and buccal surfaces of the teeth being covered with plaster, and the parting made so that the plate will be retained upon the model, while the pieces of the bar can be readily removed. After the flask is opened, the pieces are removed, the usual gateways cut, and the packing, vulcanizing, and finishing done as usual.

" In the case of an entire lower set broken through the center, it will be seen that the same directions will apply, excepting as to the amount of rubber to be cut away. A free cut should be made on the lingual side, extending through under the teeth, to and including the labial band; so that the broken surfaces will be entirely obliterated, and at least ⅛ of an inch in width of new rubber supplied between the cut surfaces. An engine-bur will do much of this work nicely, and a wheel-bur is very convenient for the purpose of scoring the surface. Making the model, flasking, and packing will be done as before.

" If one of the incisor blocks be broken, and needs replacement, a new one can be fitted after the model is obtained, and the remaining steps of the process followed as has been described.

" Upper plates are sometimes cracked in the center, the crack extending from under and between the incisor teeth backward over the palate. This often happens from the amount of rubber just behind the incisors being insufficient. It is not unusual to see it cut away at this point, so that the pins are almost or quite exposed, the plate having its usual thickness at a very short distance behind the teeth. A much larger amount of material will be tolerated here than is usually employed, and often with benefit, not only to the strength of the plate but to the articulation of the wearer. The curve of the surface of the plate should be made to resemble that of the palate before the removal of the teeth, and it

will be found that the extra thickness may extend for ½ of an inch behind the teeth without annoyance to the patient.

"A proper curvature to the surface of the plate, just behind the incisors, will do much to prevent the disagreeable whistling in making the *s* sound, and will assist in giving the correct enunciation to *sh, zh,* and other linguals.

"If the cracked plate fits a flat mouth, a model can often be drawn from it as it is; but if the arch is high, and the gums projecting, it is better, after thoroughly cleansing and drying the plate, to finish the cracking by breaking the plate entirely in two. The two halves may now be fastened together by dropping shellac upon the lingual side, and a model secured, from which either half of the plate can be easily removed. The whole palatal portion of the plate can then be removed by a saw cut, leaving only a narrow margin on the lingual surface inside the teeth. The remainder of the surfaces of fracture are cut away as directed in case of the lower plate, the new surfaces roughened, the pieces of the old plate replaced upon the model (which has received its coating of liquid silex), waxed up, flasked, packed, and vulcanized, the teeth being retained upon the model as before described. The plate, when finished, will show the old rim and a margin of the old rubber inside the teeth.

"It is sometimes desirable to change the substance of the plate entirely, as in case of supposed mercurial poisoning by red rubber; or at least to put what red rubber there may be about the plate entirely out of sight, and to reduce its quantity to a minimum. If this is to be done to the plate last under consideration, it should be prepared for flasking as described, excepting that the labial band should be cut away, and everything arranged so that the plate can be separated from the model when flasked. The parts cut away should, of course, be replaced by wax. The cast is now set in the flask so as to leave the parting at the upper edges of the gums. The plaster is varnished and oiled, and more plaster built on against the labial sides of the teeth, extending from their cutting edges to the edge of the flask, and again varnished and oiled, so that the appearance will now be precisely similar to a plate flasked so as to be retained upon the model. The ring of the flask is now put in place and filled, and the plaster allowed to harden.

"When the flask is separated, the teeth will be found in its ring section. A few blows of the hammer will dislodge them, with the piece of plaster built against their labial surfaces. This is carefully broken away, in two pieces, if possible, which are preserved, and the teeth and rubber incasing them are left. The rubber is now filed away as much as is practicable, leaving none of the old rubber in sight, and removing enough from the palatal surface to make a new fit to the model. The teeth and plaster are replaced in the flask, and the case is ready for packing and vulcanizing; when finished, none of the old rubber will be seen, and the plate will be practically as good as though the teeth had been removed from the old plate and reset.

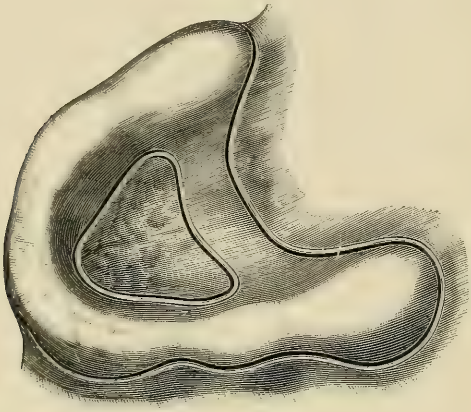
"It is evident that the change from red to black rubber just described, can be made with a whole plate or a broken one indifferently. If a change of articulation and a new fit to the mouth is also desired, on account of shrinkage of the gums, the plate should be prepared so as to draw from the model, and a few small pieces of wax put in the palatal side to bear upon the alveolar ridge, and give the right articulation by trial in the mouth, the center of the plate being cut away to facilitate the fitting of the plate to the model. A fresh model of the mouth being secured from an impression, the plate is waxed on to it, the case is flasked with a false piece of plaster built against the labial sides of the teeth, as has been described, and the plate removed and cut away as much as desired, a considerable amount being always taken from its palatal surface."

Beaded or Grooved Dentures.—For the exclusion of air and moisture from between the artificial denture and the mucous membrane of the mouth, a groove may be cut in the plaster cast, as shown in Fig. 139, which is taken from an article in the *Dental Cosmos,* contributed by Dr. W. Storer How. The bead must be carried continuously around the outer portion of the cast, just inside the plate line. This inclosure will produce a chamber-like function of the entire inner surface of the denture, see Fig. 140. The resulting greatly increased adhesion, especially noticeable in mouths having flat and soft surfaces, is a gratifying effect of the device.

Partial dentures, as shown in Fig. 141, may thus be securely retained, and the simplicity of the process is hardly less remarkable

than the successful result. It is only essential that the scraper shall be shaped and operated to produce a suitably smooth, nar-

FIG. 139.



row, half-round groove in the model, and follow previously studied lines along the palatal soft parts and at the merging of the muscles in the gums. The inclosures may be of any size or shape or

FIG. 140.

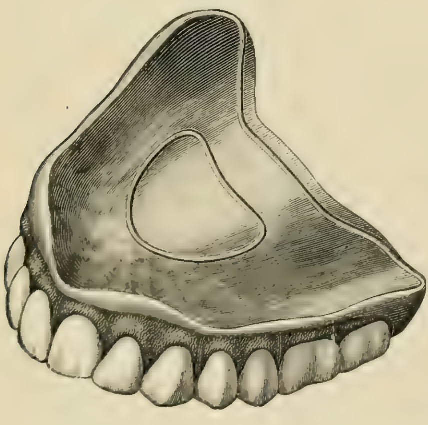
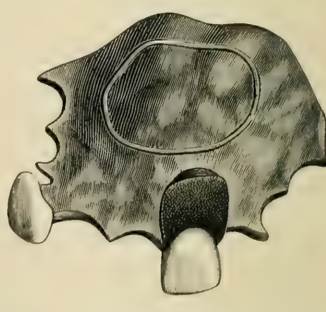


FIG. 141.



number that a careful preobservation of the character and conformation of the mouth may indicate.

CHAPTER XXIV.

CELLULOID BASE.

The employment of celluloid in prosthetic dentistry, notwithstanding the very general failure which attended its first introduction into practice, came rapidly into general professional favor as a cheap, convenient, and serviceable base for artificial dentures. With the more recent improvements in the manufacture and seasoning of blanks, more perfectly adapted appliances for molding, and a more extended acquaintance with the peculiar and distinctive characteristics of this material, it has, in the practice of many, superseded, in a great measure, other plastic vegetable substances for the purpose indicated.

It is more in harmony with the soft tissues of the mouth, more cohesive in texture, approximates more nearly the natural gum color, contains less vermilion pigment in its composition than does rubber, and is less objectionable by reason of the comparative cleanliness accompanying its manipulation.

Celluloid, as at present produced, and when properly manipulated, does not, in any appreciable degree, undergo change of form after molding by warping either in or out of the mouth, as was formerly the case. It loses somewhat the freshness and clearness of its original pink color, however, after having been in use for some time, in many cases in a very marked degree.

Though not bearing so perfect a resemblance to the complexion of the healthy gum tissue as the porcelain imitations, yet the near approximation of celluloid to the desired color makes the use of single plain teeth admissible for permanent dentures, and this is unquestionably its crowning merit, and makes it the most desirable of all the so-called "cheap bases." The *indiscriminate and almost universal* employment of block or sectional gum teeth in connection with rubber has done more to degrade the prosthetic department of dental practice than all other causes combined. The optional arrangement of each individual tooth to meet the

requirements of special cases in respect to expression, articulation, and antagonism is one of the absolute and indispensable requirements of a perfect artificial denture.

Composition and Manufacture.—The following is the substance of Dr. C. J. Essig's account of the composition and manufacture of celluloid:

Celluloid is derived from cellulose, a woody fiber, constituting the framework or foundation of plants.

Linen, cotton-wool, hemp, etc., are examples of cellulose. For the manufacture of celluloid, the cellulose is first converted into paper; hemp is the form of cellulose employed for this purpose, because it has been found to make the strongest paper, and the stronger the paper the better the celluloid.

The hemp is first converted into paper in the usual way by paper machines. By this process the form of the material undergoes a physical change only, while chemically it remains the same, viz., nearly pure cellulose, and has a formula of $C_6H_{10}O_5$. The cellulose, now in the form of hemp-paper, is converted into pyroxylin by a process technically known as "conversion," this change being effected by immersing the hemp-paper in a strong mixture of nitric and sulphuric acids for a sufficient length of time, when it is removed from the acids and washed thoroughly.

It is now still in the form of paper, but it will be found to have increased in weight about 70 per cent., and to have become highly explosive, taking fire at about 300° F.

Pyroxylin, then, is the chief ingredient in celluloid, and is reduced to a pulp in a machine similar to that used in paper-making; a thorough mixture is then made of:

Pyroxylin,	100 parts.
Camphor,	40 "
Oxid of zinc,	2 "
Vermilion,	0.6 "

Some alcohol is used to soften the camphor. The mass is now put under a hydraulic pressure of 2000 pounds to the square inch. The cylinders in which it is pressed have a small orifice in the side near the bottom, and when pressure is made the celluloid is forced out through this orifice.

The immense pressure is to condense or solidify the celluloid,

and as it is forced out it is cut off in pieces of the proper size, and molded by pressure and heat to the forms in which we receive it. At this point the blanks are still soft, and require to be seasoned; this requires about two months, during which time they are kept in a room at a temperature of 160° F.

Processes Preliminary to Molding.—While many of the processes entering into the construction of artificial dentures, with celluloid as a base, are essentially the same as those required when rubber is used, yet there are, in many important respects, modifications of practice made necessary by the peculiar nature and behavior of the material employed.

When the distinctive characteristics of celluloid are well understood, and the operator is familiar with the approved methods of working it, no unusual difficulties attend its successful manipulation. To attain uniformity and satisfactory results, however, it is absolutely necessary that there should be a faithful compliance with every manipulative detail, however seemingly unimportant, which experience in the use of this substance has demonstrated to be essential.

Plaster Model.—The inferior plasticity of celluloid, compared with vulcanizable rubber, when exposed to the action of heat, and the consequent greater pressure necessary to mold it into any given form, makes it necessary to give to the plaster model the greatest practicable hardness and strength. To secure these important qualities it is recommended to use the best quality of coarse builder's plaster, which, though it does not set so quickly as the finer and whiter varieties, becomes much harder and more resistant to pressure when thoroughly dried. Increased hardness will be secured by adding to the plaster mixture a small quantity of clean white river or lake sand or marble dust.

A smoother face will be given to the model by first coating the surface of the impression with a moderately thin mixture of fine plaster, and, as this begins to set, fill in with the coarser variety for the body of the model.

The plaster for the model should be mixed as thick as can be well poured, taking care, as it is slowly introduced, to expel any confined air by tapping or shaking the impression-tray as the plaster flows in.

In cases where there is any considerable anterior projection of

the alveolar ridge in front, above or below, the corresponding portion of the plaster model is liable to be crushed under the pressure necessary to mold celluloid. To prevent such accident, it has been recommended, in addition to the expedient to be mentioned hereafter, to place in the front part of the impression a curved piece of brass plate punched full of holes, ½ or ¾ of an inch wide, which, when the impression is filled, will be imbedded in the central portion of the plaster ridge, and extend some distance into the body of the model.

Metal Casts.—In extreme cases, where the ridge is very thin and the projection spoken of excessive, it is safer and better practice to substitute metal for plaster in forming the model. In this case the latter may be obtained by pouring block-tin or Babbitt metal directly into the plaster impression, which should first be thoroughly dried, and the cavity for the air-chamber formed before pouring.

A solid metal cast, however, should never be employed when there is any considerable undercutting, as is often the case on either side of the median line in front, forming the canine fossa, and posteriorly underneath the maxillary tuberosities, since, in such cases, it will be impossible to detach the metal cast from the case when molded. The separation can be readily effected by substituting a metal shell for the solid cast. The shell is formed in the following manner: Secure a perfect mold of the plaster model in sand, and pour into this fused block-tin of the purest kind, pouring it as hot as can be without producing bubbling of the metal. As the metal cools first at the surface, a shell will form externally in a few seconds, when the box containing the mold should be inverted and the central fluid mass poured out quickly at the back part of the mold in order to secure the thinnest portion of the shell in front, where it should not be thicker than ordinary card paper. A little practice, with a few failures at first, will enable the operator to secure the desired thickness of the shell with tolerable exactness. When obtained, the shell is filled in with hard-setting plaster to form the metal-faced model to be used in molding the celluloid. When the case is finished and the plaster removed from the shell, the overlapping borders of the latter may be readily drawn in toward the center with pliers, and the shell disengaged from the undercut spaces.

To facilitate its removal, the shell, before filling in with plaster, may be divided vertically at intervals with a fine saw, extending the cuts from the margins to near the summit of the ridge.

FIG. 142.

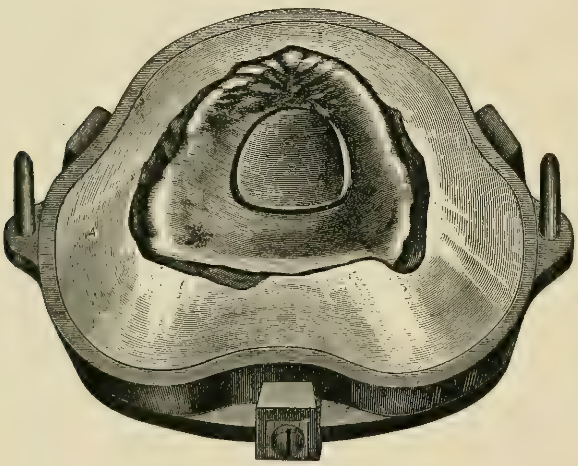
Waxing or Modeling.—After having arranged the teeth for any given case, place them with the trial plate on the model, and build out with wax, paraffin and wax, or modeling compound. In carving or modeling these materials, much time and labor may be saved in final finishing of the piece, and a more compact surface given to the celluloid, by securing in the first place the exact form and fullness required in the completed set. When this is done with instruments especially adapted to the purpose, the general forms of which are represented in Fig. 142, additional smoothness of the surface may be obtained with a blowpipe flame applied in such a way as to produce simple surface fusion of the wax or other material. The palatal and exterior surfaces may then be covered with No. 60 tin-foil, carefully burnished into close contact. A closer imitation of the granular appearance of the natural gum exteriorly may be obtained by pitting or "stippling" the surface with a small pointed instrument, care being taken not to perforate, but simply indent, the foil; or a flat-faced serrated plugger may be used for the same purpose.

Investing.—The piece prepared as above is then placed in a flask especially designed for celluloid (see Fig. 143), invested in plaster, and the mold

or matrix formed in the same manner as practised when rubber is used. In case the ridge overhangs, or is undercut, the model, before being incased in the lower section of the flask, should be cut across diagonally, with the slope toward the heel of the model, thus depressing the latter posteriorly. By this means the projecting portion of the ridge will be brought more directly in a line with the pressure in closing the flask.

It is quite as important that the incasing plaster forming the matrix should be as hard and resistant to pressure as that entering into the composition of the plaster model. If this condition is not secured, there will be great danger, not only of fracture of the

FIG. 143.



model for the want of adequate lateral support, but of displacement of the teeth by being forced into the plaster. So important is the right condition and manipulation of plaster in the use of celluloid, that the writer feels warranted in adding, to what has already been said in this connection, the following judicious comments contained in a pamphlet issued by the manufacturers of celluloid:

"Plaster should always be mixed *as thick as possible,* and, if convenient, allowed to set over night, with the flask open, and dried in a warm place, as it is thereby rendered much harder. Simple as the operation is, comparatively few understand how to mix plaster so as to get the greatest strength and resistance to pressure. The

proper way to mix plaster for both models and filling flask is as follows: First, stir the plaster as thick as can be well poured, taking care that there is no excess of water; pour some of this into the flask or impression to be filled, and shake down well. Then, into what remains in the bowl, stir more plaster until you have a mass so thick that it can be piled up. With this the flask is filled up and thoroughly shaken down. It is surprising how much plaster can be stirred in after the first is poured out, and also how thick a mass, such as described, will settle down in the flask without bubbles. The thinner plaster first poured in will run and be driven, by the thicker afterward added, into all the crevices, and most of it will escape from the flask, leaving a body of solid, resisting plaster that cannot be obtained by the ordinary method of mixing."

In flasking the case, *the line of separation between the upper and lower sections should be along the borders of the plate.* This is particularly necessary when the gum is "stippled." When the piece is incased, and the plaster has sufficiently hardened, the two sections of the flask should be carefully separated, and this can be done with greater safety to the model and other portions of the matrix, and with less liability of loosening and detaching the teeth from the plaster, by first applying just sufficient heat to the flask to soften the wax and trial plate, *being careful not to melt the wax by too great or long-continued heat.*

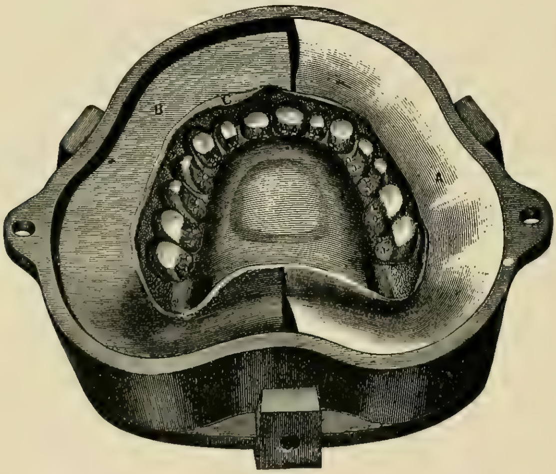
When the flask is separated, all portions of wax or other material should be carefully and thoroughly removed from the mold, and if any remain, not accessible to instruments, the section or sections of the flask containing remains of wax should be placed in a clean vessel under clean water and well boiled until all is expelled. The thin, frail edges encircling the matrix in both sections of the flask should then be cut away somewhat, and well rounded to prevent fracture and consequent mixing of particles of plaster with the celluloid in molding. When this is done, put the flask together and see if there is ample room for the "nose" of the model to pass the edge of the matrix.

To permit the escape of surplus material in molding, either of the following plans may be adopted: 1. Cut two concentric grooves in the plaster of the upper or lower section completely encircling the matrix, the inner one not less than ¼ or ⅙ of an inch from the margin of the mold, and the other at the border of the flask, the

inner side of the latter forming a part of the outer groove. 2. Bevel the plaster around the mold, commencing at the margins of the tin-foil C, and extending it to the sides of the flask, as shown at B, Fig. 144.

In no case should cross grooves be made communicating with the matrix, as these afford too ready an exit for surplus material, and prevent that "back pressure" so essential to a complete and compact filling of the mold. The grooves should be deep and ample enough to receive all surplus, otherwise it would be difficult, if not impossible, to close the flask perfectly. In the use of gum teeth, holes may be drilled in the matrix inside the teeth, opposite

FIG. 144.



each joint, not over ⅛ of an inch in diameter, and as deep as it may be deemed necessary. These act as waste gates, and relieve the blocks from pressure.

Selection and Preparation of the Celluloid Plate or Blank.—The mold having been prepared in the manner described, a suitable blank should be selected, and, as it is important that this should be, as nearly as possible, the size and general form of the mold, a good assortment of plates, for both entire and partial pieces, should be at command from which to select for any given case. Special attention is directed to this important requirement. Celluloid does not, like rubber, flow together and intimately inter-

mix when exposed to heat and pressure. If, therefore, the blank is, in any considerable degree, wider than the model, or its central or palatal portion fuller and deeper than that of the model, the material, when under pressure, will lap or fold upon itself along the lateral walls of the arch, and, failing to unite, will form grooves or fissures. On the other hand, if it is not wide or deep enough, the material is liable to be stretched and torn. The blank should be just large enough to fill all parts of the mold perfectly, with some slight excess, and the central portion should always be somewhat thicker than the corresponding part of the trial or pattern plate.

As celluloid cannot be depended on to flow from one part of the mold to another, it is important that there should not only be an excess of material, but that this excess should be, as nearly as practicable, distributed throughout all portions of the matrix. A neglect of this precaution will result either in an imperfect filling of the mold in some places, and consequent defect of the plate, or a porous condition of the celluloid will be found wherever the material, though apparently filling the mold, has not been impacted with sufficient force.

The selected blank should be conformed as nearly as possible to the shape of the mold by heating it in boiling water and pressing it with the fingers into the section of the matrix containing the teeth; after which the necessary fullness of the several parts of the blank may be obtained by dressing away redundant portions with files, a small bracket-saw, or the knife, first softening the plate in boiling water before using the latter.

Greater exactness in the required amount of celluloid necessary in any given case may be obtained by measurement, the simplest method being by the use of the Starr instrument for measuring, illustrated in the chapter on Vulcanite. It must be remembered, however, that this device only determines the aggregate amount of material necessary, and that, while it may be a safe guide in the use of rubber, which flows freely, it may lead to failure when celluloid is employed, unless care is taken that all parts of the blank correspond with the capacity of the mold.

A more reliable though somewhat tedious method of securing exactness in the quantity and distribution of material necessary, and which acquires special value in cases where there is unusual danger of fracture of the model or teeth, and especially of the latter

when gum teeth are used and these are ground very thin, is the following, given by a correspondent of the *Dental Cosmos:* "After preparing the case ready to flask, remove the teeth from the pattern, stop the pin-holes, then remove the pattern and carefully flask it. When the mold is ready, remove all the wax or material of the pattern; place the celluloid 'blank'; apply heat, and cast the same as if for final case. Remove the flask from the heater; place it in the clamp and cool rapidly. When it is entirely cool, remove it from the flask, and trim as carefully as for final case until the blank is almost the same as the pattern in thickness (it always comes out thicker). Now you have a blank with but little excess; —only what the vacuum and pins displace, or slightly more, and exactly the shape of the pattern, minus the teeth. Set up the case again, being careful to make the pattern the same size; flask, and when ready remove the pattern; if doubtful as to amount of excess, pare the edges of the mold slightly, which will be all that is needed. Replace the blank; apply heat, when but moderate pressure will be found necessary to bring the flask entirely together. If dry heat is preferred, dip the edges of the blank to come in contact with the pins in spirit of camphor for a few minutes before casting."

Before the blank is placed in the flask preparatory to molding, some provision should be made against adhesion of the plaster to the plate. This may be done by oiling the surface of the model, or by coating it and other portions of the matrix with either collodion or liquid silex, or by rubbing the surfaces well with French chalk or powdered soapstone; or a layer of tin-foil may be interposed between the model and blank. The following novel method of coating the surface of the model with tin is recommended by Charles P. Alker, of Bordeaux, France: "Reduce ordinary collodion with about three times its bulk of ether, and add powdered tin until the solution is well impregnated with the metal. The tin is the same that is sometimes used for coating plaster images. When properly mixed and applied with a brush, an even covering of tin is formed upon the model, so dense as to closely resemble tin-foil, and so firm as to not be detached by boiling water or heat. The plate is readily cleansed with a coarse brush, and presents the appearance of having been made in a metallic mold."

More perfect results, however, it is believed, can be obtained in the use of a metal-faced model in connection with the use of tin-foil, as before described. A piece thus incased in metal will require no more final finishing than is necessary to remove surplus material and dress and polish edges.

The case, thus described, is now ready for molding.

Molding.—The various machines or heaters now generally employed in molding celluloid into dental plates contemplate the use of either glycerin or oil, steam or dry heat, for the purpose of producing the requisite plasticity of the material subjected to pressure. There is considerable diversity in the form and construction of heaters designed to utilize the several mediums for the conduction of heat, as well as differences in the modes of applying pressure, and while each has, doubtless, some special points of merit not possessed by others, satisfactory results may, with careful and intelligent manipulation, be attained by the use of any one of the many recommended. The limits of this work will only permit the introduction of such as are believed to be in most general use.

Hot Moist Air (so-called "Dry-Heat") Machines.—In the use of these heaters, the water with which the plaster is impregnated is relied upon to produce the steam necessary to carry off all excess of camphor from the celluloid in the process of molding. An essential point by this method is to have the plaster in the flask thoroughly wet, and this may be better attained by setting the flask in a vessel of water before placing it in the heater. To provide against insufficiency of moisture in the plaster, a small quantity of water may be introduced into the tank before applying heat.

Fig. 145 represents a modeling or packing machine of the class here spoken of, and is designated as the "Best." The inside chamber is of cast-iron, surrounded by a sheet-iron casing. The lid, of cast-iron, forming a part of the clamp, is pierced for the passage of three wrought-iron screw-bolts—the nuts being on the upper side and easy of access. When these nuts are turned for the purpose of closing the clamp, the bottom portion of the clamp is drawn up by each revolution away from the flame, thus avoiding the danger of overheating the plate, and securing a uniform heat. The bottom of the cast-iron chamber and the lid

are pierced with holes, to allow a circulation through the chamber, for the purpose of carrying off the camphor which is disengaged in the process.

With the celluloid blank adjusted to its proper position in the flask, the latter is placed in the clamp and the top screwed down until it slightly presses the clamp. It is then placed in the oven or tank and heat applied.

If gas is used, the form of burner shown underneath the heater in Fig. 145, which gives a pure blue flame without smoke, may be used. If gas cannot be commanded, however, any of the alcohol or kerosene lamps commonly employed in vulcanizing may be substituted; or the "Hot Blast Oil Stove," especially adapted to the "Best" machine, and exhibited in connection with the latter in Fig. 146.

Having applied the heat, it is of the first importance that unremitting attention should be given to the process of molding until it is completed. If pressure is applied before the celluloid is rendered somewhat plastic, or too great force is exerted during the earlier stages of the process, and without sufficient intervals of rest, there is danger of crushing or fracturing the model and of impairing the articulation by displacement of the teeth. On the other hand, the nature of celluloid is such that if it is exposed to a temperature of 270°, without being under pressure, the camphor evaporates, and the material, besides being rendered hard and intractable, is puffed up, exactly as a loaf of bread is raised by yeast, and filled with air-cells, and thus rendered porous.

Celluloid begins to soften at about 225°, and will then yield slightly to pressure, but this should be applied very gently at first, with no more force than can be readily exerted with the thumb and finger. As the heat increases, and the celluloid becomes more and more plastic and yielding, the pressure should be correspondingly increased, but always interruptedly, giving the material time, between each turn of the screw or nuts, to escape from under the pressure. No considerable amount of pressure will be required in any case until near the close of the operation, when the mold is completely impacted, and the excess is being forced into the grooves or gateways as the flask comes together.

At this point considerable force will be necessary to close the flask perfectly, and somewhat longer intervals of time should occur between each turn of the screw or nuts.

FIG. 145.

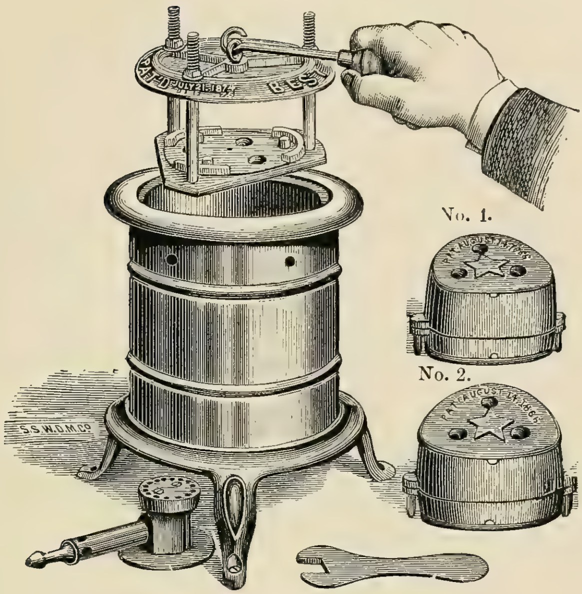
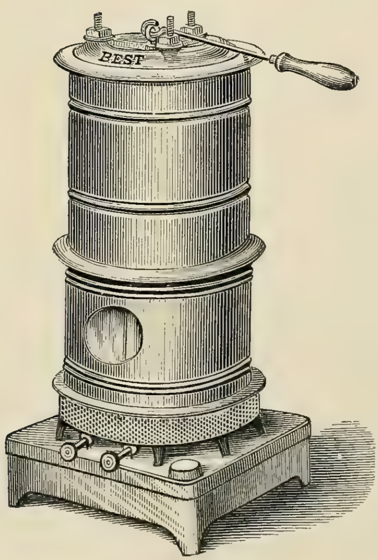


FIG. 146.



During the progress of the molding, the flask should be withdrawn occasionally for inspection. If, in the case of central pressure, the flask is found to be closing unevenly, it should be loosened in the clamp and readjusted in such manner as to correct the faulty approximation. No difficulty will be experienced in this respect in the use of clamps provided with screw-bolts, as pressure may be applied at any point, and the flask be made to close uniformly without the necessity of shifting the latter.

The moment the flask is completely closed the heat should be turned off, and the piece allowed to cool gradually. In no instance should the flask be removed from the clamp until it is *stone cold*. In cases where the material is of extra thickness, or where the shape of the blank is totally altered, longer seasoning is advisable, and the flask should be placed near a stove or over a register (keeping it closed by a clamp, or by an instrument or piece of iron put through the holes in the standard) for half a day or more, at a temperature not over 140°. If these directions are observed, no trouble from warping plates will be experienced.

Molding in Steam.—In using the steam machine, care should be taken to keep it in good order. The screw should be well oiled with only the best sperm oil, which will not gum, and kept so that it can be easily turned with the thumb and finger. If the machine, when received from the depot, works hard, the screw should be run out, the gland unscrewed, and the rubber packing loosened up, so that it will not bind the screw. Do not turn it down tight again until you heat it up, when, if it begins to leak, it can easily be tightened. Bear in mind that *turning this gland merely prevents the escape of steam, and does not affect the pressure on the flask.*

The safety-valve should be kept free from gum, and if either it or the screw is clogged, it should be well cleansed with kerosene. This valve, in the machine now sold, is so constructed that it blows off at about 275°, a temperature that celluloid will bear very well; and as the heat, *so long as water remains in the boiler,* cannot, if the safety-valve is kept in order, be raised above that point, it is impossible to *burn* a plate in this machine. While this is true, it is also true that *too long* an exposure to even 275° in steam tends to injure the quality of the celluloid, and for this reason the heat should be continued no longer than necessary, but should be

reduced at once by blowing off steam as soon as the molding is completed. The first machines were constructed with the safety-valve much heavier, and all in one piece, and were adjusted to a temperature of nearly 300°, which was higher than necessary or advisable. It is recommended, therefore, that those having that style of valve should cut off about one-fourth in weight from the lead weight, which can easily be done by removing a little wire which passes through the stem and weight. A modern valve will be furnished when ordered. When molding, fill the boiler partly full of water. The amount is not material, but there should always be enough to cover the ribs at the bottom. Have the screw well turned back, until the plunger, when placed in position, will rest against the top of the boiler, otherwise the flask may be pressed upon while screwing down the cover and the cast injured. Turn down the cover snugly; see that the gland is turned back, and the screw works freely. Many failures have occurred by neglecting this simple matter. If it works hard, it is impossible to tell how much or how little pressure is being exerted; there may be too much, and blocks or cast be broken; or too little, and the plate made porous. In all methods of working celluloid, the *sense of feeling* is the best guide as to when and how hard to turn; but in order to have this, there must be perfect freedom of motion of the parts. The *time* elapsing before turning is not reliable, as it varies with the heat employed, the temperature at starting, the amount of water in the boiler, the drafts of air to which the flame may be subjected, etc.

After placing the flasks in position, turn down the screw *very gently*, with thumb and finger, until you feel it touch the flask. Fill the cup with alcohol and light it, or light the gas. The safety-valve is made in two parts. The upper portion may be suspended by the pins in the lead weight; the valve will now blow off steam (if in proper order) at a temperature of 225°. Until this occurs, no particular attention is necessary, but from that time the exclusive attention of the operator should be given to the molding. Many failures occur from the want of this, for the plate may be easily injured from too much heat without proper pressure. But fifteen or twenty minutes, at the most, will be required from this point, with proper heat, and nothing else should be attended to.

At the point when the steam escapes from the valve with the

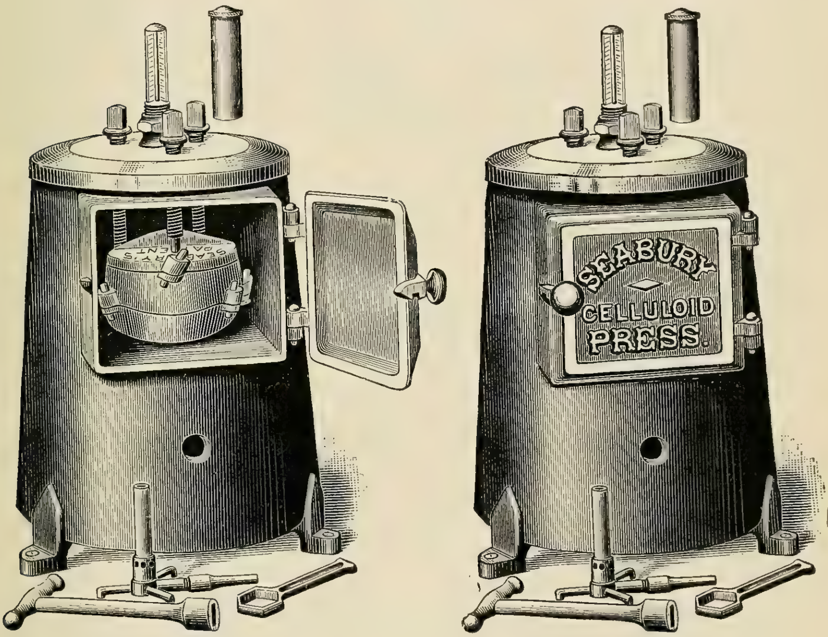
upper portion suspended, the plate will soften, and the screw will be felt to yield to light pressure with thumb and finger. The upper weight should now be dropped down. Turn the screw *very carefully*, stopping when you feel the resistance increase; as soon as it yields again, turn it more, going slowly and carefully at first, but increasing the pressure somewhat as the steam gets up, which you will know by occasionally raising the valve. It is just here that judgment is required to avoid, on the one hand, too much pressure before the material is sufficiently softened, which would result in fracture of the cast or blocks, disarranging the articulation, or a "flaky" plate; and, on the other, too little pressure after the heat is up, which would result in injuring the quality of the material. The pressure should be followed up as the heat rises and the screw yields, the object being to get the whole of the plate under pressure, in every part of the mold, by the time the steam blows off quite sharply and steadily on raising the safety-valve. After this the pressure should be increased, but time should always be given between the turns for the slowly flowing celluloid to escape from under the pressure. Toward the close of the process, the pressure should be considerable; in fact, about all that can be applied with the machine, and should be continued as long as the screw can be turned. If the operation has been properly timed, the steam will blow off at the safety-valve at about the time the molding is completed and the alcohol in the cup is consumed. If it should blow off before that, no harm would be done, as the heat cannot become too great if the safety-valve is kept in proper condition. These remarks apply to the use of alcohol in the cup furnished with the machine. If any other heat is used, the flame should be sufficient to complete the process within thirty to forty minutes. If more than this time is consumed in the molding, the quality of the plate is injured.

Do not allow the water to be all converted into steam, as the steam would then become superheated, and a dangerous condition ensue or the plate be ruined, while the safety-valve would not indicate it. Always have plenty of water in the boiler, and if steam should cease to issue on raising the valve, the heat should be at once withdrawn.

It has been demonstrated by experimental tests, and is now very generally conceded, that the best results are obtained in the use of

celluloid by subjecting it to *dry* heat in the process of molding, the material, when exposed to a high temperature under such a condition, retaining most perfectly its form, color, and consistency. Hence the celluloid presses of more recent introduction, while they are also equally well adapted to vulcanizing by the same means, are provided with a distinct chamber in which hot air, of a higher temperature than can be safely employed with glycerin or steam, is utilized to secure the greatest practicable plasticity of the

FIG. 147.



Open. Closed.

celluloid. Approved appliances of this kind are those devised by Drs. Seabury and Evans.

Molding by Dry Heat.—When the investment is thoroughly dried, insert and carefully adjust the selected blank; place the flask in the oven (see Fig. 147) immediately under the screws; see that the two sections are so placed that the guide-pins will enter properly into the lugs; turn down the screws until they bear lightly upon the top of the flask, and close the machine. In less than

five minutes the material will be sufficiently softened to permit the commencement of the molding. The screws will turn readily with the thumb and finger (using the smaller key-wrench), when the blank is properly softened. Close the flask gradually, stopping occasionally if the resistance is very material. Usually, if the temperature is about 300°, the flask can be closed in ten minutes; but if a very thick blank is used, the molding must proceed slowly. As soon as the flask is closed—unless a lock flask is used—the flame should be extinguished, the door opened, and the machine allowed to cool. If a lock flask is used, it may be removed and thoroughly cooled before opening it, the oven being meanwhile ready for another case. The cooling may be accomplished rapidly, if necessary, by placing the flask in water. When perfectly cold, remove the plate from the investment; it will be found enveloped in the tin-foil which had been burnished to the wax plate. Peel off the foil. The celluloid will present a hard, brightly-polished surface, received from its contact with the foil, and will need no further finishing than cutting off the excess of material and smoothing down the edges.

In the use of material, as a base for dentures, possessing properties so extremely sensitive to heat as that of celluloid, and so liable to suffer changes of color and structure materially affecting its usefulness by a misapplication of heat and faulty manipulation, everything that contributes to a better understanding of its behavior in the process of molding must be of interest and practical value. The following experiments of Dr. J. Stewart Spence, of San Francisco, Cal., throw some additional light upon the subject. He says:

"Having just made more than 30 experiments with celluloid and the New Mode Heater, I have met with some interesting facts, of which, during two years' previous use of the apparatus, I was ignorant. The main results I will now give before relating the experiments, thus inverting the usual order of placing results last, for the sake of perspicuity.

"1. Plaster investments require one and a half hours to dry in the oven of the heater, with the thermometer at 400°, and half an hour more to raise their heat to 320°. Drying them over a gas-burner takes nearly as long, and loosens the plaster from the flask. A thermometer placed between the slightly separated halves of

the flask in the oven indicates when this heat is reached, at which time a blank previously prepared, should be expeditiously inserted.

"2. Celluloid may be molded in from five to ten minutes at 320°; in about twenty to twenty-five minutes it degenerates, becoming brown, hard, brittle, and porous, and in twenty-five to thirty minutes it burns up.

"3. Celluloid will burn at either high or low temperatures, according to the length of time it is exposed to them, as well as their degree of heat. Thus it is unsafe to leave it at even a low heat for a long time, as in slow cooling.

"4. Celluloid is more liable to spoil if not under pressure, and those parts of the blank least subject to pressure are most liable to come out damaged. Therefore flasks should be closed with all expedition.

"5. Celluloid, unless worked at a high temperature, so as to flow readily, and with well-hardened plaster, will press the model out of shape and teeth out of position.

"6. Steam brought in contact with heated celluloid makes it puff up and degenerate.

"7. Plaster retains heat longer than metal, and therefore plates left in the oven to cool may spoil or burn up even when the temperature of the heater has fallen to a low degree.

"8. Tin-foil discolors celluloid at a high heat, making it browner.

"9. Celluloid after molding is hardest at the surface, as may be clearly seen in a plate that has been slightly overheated, it being porous internally, but very hard on its surface.

"Instead of giving a copy of my record of these experiments, which would be unnecessarily prolix, I will give a condensed account of them by series.

"1st Series. *To test the heat of the oven.* I placed in the dry oven a separate thermometer, which, with the door closed, registered the same as that outside; then reversed them with similar results. Removing the central screw from the top did not reduce the temperature perceptibly. Removing the door reduced it a few degrees. Removing both door and screw caused a rapid decrease from 320° to 290°.

"2d Series. *To test the heat of oven with plaster in it.* I filled a

half flask with plaster and placed it in the oven with a thermometer on the floor beside it, of course closing the door, the outer thermometer standing at 320°. After twenty minutes the inner thermometer had reached only 300°, showing the cooling effects of the plaster on the air of the oven. Moved the thermometer on to the plaster; the thermometer fell considerably, and while the outer thermometer rose in thirty minutes to 440°, the inner reached only 290°; steam was then admitted to the oven, and it ran instantly up to 340°; steam was then shut off, and the outer thermometer maintained at about 360° for thirty minutes longer, by which time the inner reached 320°. At this point some steam was let off, which ran the outer thermometer 20° below the inner, showing that plaster is slow to part with its heat as well as to receive it.

"Further experiments were made in drying plaster, both in the oven, with steam and without it, and out of the oven over a gas-burner; also with plaster mixed with pulverized pumice and mixed with marble-dust. It was found that in the oven with either steam or dry heat, and the outer thermometer at 400°, about thirty minutes were required to dry and heat a small half flask of plaster to 320°, and about two hours for a full flask. Done over a gas-burner, under an inverted flower-pot, a little less time was consumed, but the investments loosened from the flasks; under higher heats they become burnt and badly checked. Those mixed with pumice and marble-dust took nearly as long to heat and became softer than the plaster alone, and so were thereafter abandoned.

"3d Series. *Testing celluloid in the oven without the presence of plaster, steam, or pressure.* A piece of celluloid placed in the oven at 320°, the heat rising, burned, after slight swelling, at 360°. A second piece remained in thirty minutes with the heat at 320°, swelled slightly, and crumbled to powder on being taken out. A third piece left in three minutes at 320° was taken out a little swollen and somewhat brittle and porous.

"4th Series. *Testing celluloid in the oven with plaster and with moisture.* A half flask of moist plaster was placed in the oven, and on it a piece of celluloid and a thermometer. The outer thermometer, starting from 320°, rose to 440°, and then fell to 360° in about sixty minutes, by which time the inner thermometer reached 320°, and the celluloid, after great swelling, ignited. (In the

previous series of experiments the celluloid had swollen but about one-tenth as much as it did in these.) Next a half flask of previously dried plaster was inserted, and the inner thermometer raised to 340°, when a piece of celluloid was dropped in, and burned in five minutes. A second piece at about 330° puffed up in ten minutes, and would probably have exploded in five more if I had not varied the experiment by admitting steam to test its effects, which were a greatly increased swelling and then gradual shriveling to a thin wafer. (That steam does not produce ignition was also demonstrated elsewhere, when its admission ran the inner thermometer up to 340°, and yet afterward, when the steam was shut off, the celluloid burned at 320°.) In the next test the dry half flask was again used, but the outer thermometer was lowered to 320°, which ran the inner one down much lower, but in forty minutes they tallied, during which forty minutes the celluloid after the first fifteen minutes began to puff, and in ten minutes more had reached full size, and then for fifteen minutes slowly shrank, then exploded.

"Both thermometers being now at 320°, a piece of blank was left in fifteen minutes, and on being taken out crumbled to powder under the slightest pressure. A second blank, in twenty-five minutes, at 300°, came out not crumbling so badly. A third at 280°, for thirty minutes, was slightly swelled and somewhat brittle and porous.

"5th Series. *Testing celluloid in the oven with pressure and plaster.* A full flask of plaster was placed in the oven, and its temperature raised to that of the outer thermometer, 320°; then a piece of celluloid was placed in the flask, which was closed down in three minutes, and in five more the piece was removed from the flask in perfect condition. A second piece was then inserted, closed in ten minutes, and removed from the oven, and in five minutes more opened in perfect condition. A third piece was left in twenty minutes, and in five more opened in perfect condition, not even discolored. A fourth piece was given twenty-five minutes in the oven and ten more before opening the flask, with disastrous results; it had crumbled to a brown powder.

"This fifth series of tests show that the material in question remains perfect under pressure longer than without it. But it is to be remembered that the investment here used must have lost some of its heat while out of the oven. Later trials seem to indicate

twenty minutes as the longest time that celluloid can safely be left at 320°. As a side issue, the cohesion of the material was tested during this series; freshly-filed surfaces were placed together, and apparently joined, but they separated under a strong strain.

"6th Series. *Testing the effect of steam on the celluloid at* 320°. The same investment was used as in Series 5, and the flask closed in ten minutes, when steam was admitted. In ten minutes more the blank came out spoiled, being disintegrated, whitish, and sticky. I have seen celluloid take on this soft and white condition when heated in water above 270°.

"7th Series. *Testing the flowing qualities of celluloid at* 320°. A piece of celluloid was placed in a flask heated to 320°, no cavity being left in the plaster to receive the celluloid. Closed in ten minutes. It sunk a bed for itself in the hard plaster, flowing but little. This is a hint as to the cause of misfits, raised bites, and thickened palates, of plates molded with soft plaster and low heats.

"8th Series. *Testing the effects of quick closing.* A full blank was placed in a full flask of plaster heated to 320°, and closed so that the halves of the flask came together on one side considerably sooner than on the other. Gave it over fifteen minutes in the oven. When opened it showed, as expected, the side of the plate which had been the latest closed porous and brittle. As a side issue in this experiment, tin-foil of two thicknesses, 18 and 60, were placed side by side on the blank, and when peeled off the surface below was of a browner color than the adjacent celluloid.

"I would hint at the possibility of the celluloid which oozes from the flask, and touches the wall of the oven, being ignited thereby in some instances. A deep excess-chamber should be cut around the model to prevent this. Moreover, this escaped celluloid, not being under pressure, is doubtless more liable to burn.

"Celluloid hardens on being subjected to dry heat, but much of this is not desirable, as its hardness is external, while inside it becomes porous, and when thus hardened is very brittle. Celluloid will burn under water, as demonstrated in a vulcanizer, at 320°.

"Thin edges of celluloid will soften in hot drinks in the mouth. Thus, the festoons of gum left thin will shrink from the tooth, pro-

ducing what may be termed a free edge of celluloid gum, under which dirt deposits, and shows through the semi-translucent celluloid. This is prevented by making the edges of the festoons of proper thickness. Another error frequently seen is that of cutting away the interdental celluloid gum (contrary to nature), thus forming cavities difficult to cleanse by the brush, producing unsightly discoloration at those points.

"The principal objection to celluloid is that after a year or two in the mouth it loses its beautiful color, and becomes of a dull vermilion shade, or even black. This will probably remain the chief objection to it. That it is not so tough nor so elastic as vulcanite, and that in consequence it wears away and loses its smooth surface in the mouth, and is unfitted for clasps, and that it is a little more difficult to work than rubber, would not prevent its popularity, if it were not for this discoloration. However, the loss of color does not always extend far into the plate, and much of it may be quickly removed with a brush wheel and pumice."

Finishing.—This is accomplished with the use of the same instruments used in rubber cases. The final polish may be given first with pumice-stone, and afterward with whiting or Vienna lime. Dr. H. D. Knight recommends a polish obtained by rubbing with an old cloth wet with camphor. This may be valuable between teeth and in places inaccessible to the brush wheel. In finishing, care should be taken not to heat the plate by friction, as by so doing the surface may be injured or the plate sprung out of shape.

VULCANITE BASE-PLATE FACED WITH CELLULOID.

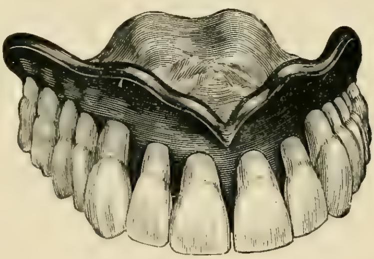
The above method of constructing an artificial denture, designated by the inventor as the "new mode continuous-gum" process, provides for the use of single porcelain teeth without artificial gums, the latter being represented by the celluloid facing. This expedient is most esteemed by those who regard rubber as a more suitable material for a base than celluloid, and who, in the use of the former, are unable to meet the requirements of a certain class of cases with either single gum teeth or sectional blocks.

In this combination work, which admits of an optional arrangement of each individual tooth, the conditions are secured which better enable the operator to effect such arrangement of the teeth as will best serve the purposes of mastication and aid in restoring

the customary facial contour and expression of the individual. Still other advantages are claimed for this method, namely, that the rubber is stronger and more elastic, and, being harder, the pins are less liable to draw or loosen, while the same property diminishes the liability to mechanical abrasion of the palatal surface in mastication, and, lastly, that in case of accident to the teeth they may be replaced with the use of celluloid, thus obviating entirely the necessity of revulcanizing, a process which always impairs the structural integrity of the rubber.

The first step in the process of constructing this kind of work consists in molding the rubber base-plate, with the teeth attached. All the preliminary processes, including the arrangement of the teeth, are the same as those practised when rubber alone is used. The teeth employed are those manufactured expressly for continu-

Fig. 148.

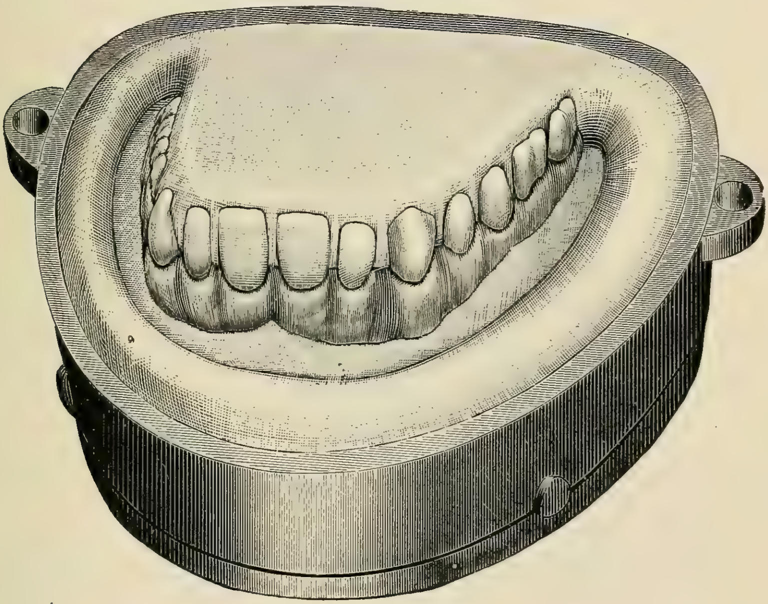


ous-gum work and celluloid, as shown in Fig. 148. In waxing up the case, all the exterior surfaces of the teeth and marginal portions of the trial-plate are left uncovered, and a strip of wax arranged all along the external border of the wax plate to form a groove for the celluloid, as shown in Fig. 148. The excavation thus formed exteriorly should extend inwardly into the interdental spaces far enough to secure anchorage for the celluloid in connection with that obtained by the grooved border. The space or spaces for the celluloid facing being thus provided for, the palatal portion is properly contoured, the case flasked, packed, and vulcanized in the usual manner. The piece, when removed from the flask, will exhibit an undercut groove along the border, and the external portions of the crowns and roots exposed in the manner shown in the illustration.

The second step in the operation consists in molding the cellu-

loid facing. The following is the method of forming the matrix and molding the celluloid: Fill up all the space between the rimmed border of the plate and crowns of the teeth with wax and paraffin, as being preferable to wax alone, and then contour it exactly as required in the finished piece; cover with tin-foil, and stipple the surface in the manner heretofore described. The case thus prepared is ready to be invested for the purpose of obtaining the matrix in which to mold the celluloid. In so doing, fill the lower section of the flask partly with plaster, and also the palatal

FIG. 149.



portion of the plate, and then place the latter in the flask with the teeth upward, raising the front part of the plate somewhat, giving it a downward inclination posteriorly, in order that the upper section, when the investment is completed, may be detached without dragging. The plate should not be imbedded in the plaster beyond the grooved margin, making the line of separation on the outside along the border from heel to heel of the plate. Additional plaster is now poured in, covering the entire palatal face of the plate and crowns of the teeth, leaving only the outer portions of the

latter and the plate exposed. When the plaster sets somewhat, pour in more plaster around the inner edge of the flask ring, forming a ridge, and also a corresponding groove or space between it and the plate. The piece thus invested will present the appearance shown in Fig. 149. The surface of the plaster is now varnished, and thin oil applied to all the surfaces. When the wax facing is covered with tin-foil, the latter should not be oiled, as it is intended that this shall adhere to the plaster when the flask is separated. The investment is now completed by adjusting the upper section of the flask and filling it with plaster. When sufficiently hard, the sections are carefully separated and the wax thoroughly removed

FIG. 150.

with boiling water. The tin-foil will remain adherent to the plaster in the upper section.

Select a celluloid blank of suitable size and saw off the outer rim, as shown in Fig. 150. Dress and carve this to near the size and form of the space to be filled, having some excess of material. Having first softened the rim thus prepared by immersing it in boiling water for a few moments, press it well into the space provided for it, and hold there until rigid. Place the two sections of the flask together in their proper relation, introduce into the oven previously heated, and close the flask in the usual way. When the piece is removed from the flask, and the tin-foil removed by peeling it from the surface, to which it will adhere, little will be required in the way of finishing except to remove surplus material at the necks of the teeth and borders of the plate,

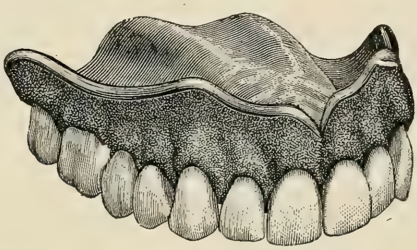
and final smoothing and polishing at these points. If the facing material has been stippled, the finished piece will present the appearance shown in Fig. 151.

The above process is also applicable to gold and cast metallic plates.

ZYLONITE.*

"A modified form of celluloid has been introduced under the name of *zylonite,* the working results of which appear to show some difference in quality. Zylonite, like celluloid, is composed of pyroxylin and camphor, but in different proportions, being, it is

FIG. 151.



claimed, a chemical combination, while celluloid is a mechanical mixture.

"Possessing translucency, the effect of zylonite in the mouth is very pleasing, and, so far as it has been tested, promises to be more durable than celluloid, without the tendency to warp or to change color when ordinary care is taken in its manipulation, which is the same as for celluloid. The zylonite blanks are uniform in color, and although this material requires the same amount of pressure to mold, it flows with a more perfect sharpness of outline than celluloid, and apparently does not disintegrate."

* Harris' "Principles and Practice of Dentistry."

CHAPTER XXV.

ATTACHING PORCELAIN TEETH TO A METALLIC BASE WITH RUBBER OR CELLULOID.

The following method of attaching porcelain teeth to a metallic plate by means of rubber or celluloid, though but little practised heretofore, is attracting more attention than formerly, and is eminently deserving of more favorable consideration and general adoption, by reason of its conspicuous and acknowledged merits, than it has ever yet received. The credit of its first introduction to the notice of the profession is due to Dr. P. G. C. Hunt, of Indianapolis, Ind., who practised the method as early as 1859, and whose published descriptions of the manner of preparing the plate-base, substantially the same as that for which Mr. S. D. Engle, of Hazleton, Pa., obtained letters-patent some years later, were given in the first edition of this work.

That it possesses marked advantages over the method of attaching teeth to a metallic plate-base by soldering is unquestionable. The waste and consequent change in the form of the plate incident to soldering, so inseparable from the older method of attachment by means of stays or backings, is wholly avoided; the strain upon the platina pins is greatly lessened by reason of the perfectly adapted rubber or celluloid socket in which each tooth or block securely rests; the liability to fracture of the teeth from concussion or violence is materially diminished on account of the pliable nature of the attaching material used; a near approximation to the natural form of the ridge or gum on the lingual side of the plate is secured; the rubber or celluloid, penetrating all the joints and openings between and beneath the teeth, renders the piece wholly impervious to the oral secretions, making it, in point of cleanliness and purity, equal to continuous-gum work; the facility with which injury to the teeth may be repaired; the practicability of remodeling the piece without impairment of the teeth or plate; its susceptibility of receiving a final finish excelled by no other method in point of artistic beauty;—these are among the qualities which

commend this method of substitution as one of peculiar merit and excellence.

In mounting teeth by this method, preference should be given to either gold, platinum, aluminium, or cast metal as a base. When silver is used, the plate should be made from refined silver alloyed with platinum, with the additional precaution of interposing a layer of tin-foil between the rubber and plate, an expedient not necessary when celluloid is employed. Aluminium has a limited adaptability to this mode of substitution, but requires special treatment in its preparation for the purpose, a description of which will be given in connection with the manner of preparing the plate.

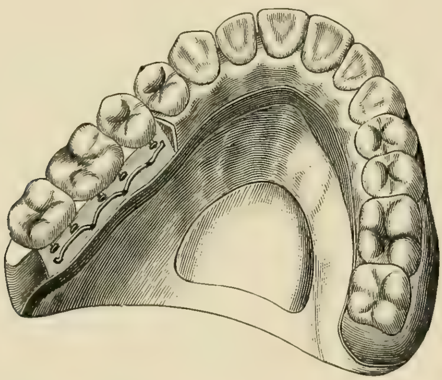
The manipulative details concerned in the construction of an artificial denture by the method under consideration are thus described by Dr. Hunt:

"Take the impression, make metallic dies, and form the plate as for work in the ordinary way. After fitting the plate in the mouth, get the articulation, the fullness and length of the teeth, remove the wax and plate from the mouth, and make the plaster articulation. If a full set, after separating the articulation, and before removing the wax from the plate, take a small, light pair of dividers, set them say one inch apart, and with one point following the margin of the wax, representing the cutting edge of the teeth, and the other point marking permanently the plaster, you have always in the dividers so set a gage for the length of any particular tooth. A convenient substitute for the dividers may be formed from a piece of wire of convenient length, one-half the diameter of a common excavator, by suitably twisting its middle for a handle, and its ends being sharpened, and pointing in the same direction, 1 or 1½ inches apart.

"Thus far we proceed as we do for ordinary gold work. We will now suppose the teeth ground and jointed, leaving as much space between the teeth and plate as the plate will admit of. We next mark with a sharp-pointed instrument on the labial surface of the plate each point where it is necessary to place a loop for purposes hereinafter described. Then apply wax to the external or labial parts of the teeth and plate in any manner sufficient to retain the teeth in position, remove the wax from the lingual parts of the teeth and plate, and mark the position on the metal where it is desirable to insert loops; remove the teeth and wax, and with a

small bow-drill make holes through the plate at the several points previously determined on for the attachments, about the size of the ordinary plate punch-hole; take a wire, or ordinary gold plate, cut in strips, say from a half to one line in width, being governed by the amount of room there is under the base of the teeth, and with small, round-nosed pliers, bend the strip around; grasp both ends with square-nosed pliers, draw the round-nosed pliers from the loop, still grasping the square-nosed pliers with the left hand, and with a hammer strike the top of the loop a sufficient blow to keep the ends from springing apart. Cut off the ends, and dress down to fit the holes in the plate, after which solder on charcoal or other suitable substance without investment."

Fig. 152.



By reference to Fig. 152, which illustrates Mr. Engle's method of providing attachment for the rubber to the plate by means of bent wires soldered to the base, the substantial identity of Dr. Hunt's mode of forming loops for the same purpose will be apparent.

With this digression, we return to Dr. Hunt's instructions:

"Pickle, dress, and polish that portion of the plate to be exposed to view. Bend and flatten the pins, arrange the teeth according to the articulation, waxing so as to cover up the loops if practicable; the loops should be placed as near the base of the teeth as possible, the rubber forming when finished a part of that general concave shape which is desirable in upper dentures, and which it is not possible to obtain with the ordinary soldered work. Then with silicate of soda paint the joints, to keep the rubber from forcing in where

it would show after vulcanizing. Flask, vulcanize, and finish up as usual. The advantages of this style of work are obvious. With this you have work as cleanly as the continuous gum, decidedly more so than the very best single gum or block-work soldered in the usual way; again, it is very much stronger, less liable to breakage, both in and out of the mouth, as the rubber gives *a perfect base* and support for the teeth to set upon. By this method *there is no springing of plates.* As your plate fits the mouth when the articulation was taken, so will be the fit when the case is completed.

"On the labial edge of the upper plate, the rubber may be allowed to project beyond the edge, if desirable, and it will be found in many cases exceedingly satisfactory to do so, and allow the rubber to be of considerable thickness near the alæ of the nose, where the loss of the cuspidati may leave a want of support to the soft parts adjacent, and which in this manner can be readily corrected. If the rubber extends upward so far as to irritate the muscular structure, a few minutes will be sufficient to make the necessary alterations. In all such cases where we have control of our patients, we place the denture in the mouth before finally polishing, so as to determine as accurately as possible the limit to which extension upward may be carried.

"The neatest work on this principle is made by carving blocks, giving to the lingual surface that regular concave form which is desirable. In this no platinum pins or loops are necessary, but in that half of the matrix on which the blocks are carved, large metallic pins are so arranged as to be hid from view in the tooth body. Different-sized pins may be used, as large as the nature of the case will admit. In short, we make the holes in the block similar to those in pivot teeth, where there is not sufficient room in the block above the tooth (or below if an under) to allow the pins to run into the body of the teeth. After burning, grinding, and fitting, get the position of the holes in the blocks relative to the plate, and drill through the plate as before, and instead of loops, solder gold wire of suitable size and length, say a very little shorter than the depth of the hole in the blocks, and two-thirds the diameter thereof; the wire should have a screw-thread cut on it, or, that which is just as good and more expeditious, barb or cut with a sharp knife. At this point of the manipulation, if it

is desired that the rubber should extend beyond the labial or buccal edge of the metallic plate, place as many loops at different points as are sufficient to retain it with firmness, after which polish the plate, wax, and proceed as before described. If you desire no rubber beyond the blocks, the roughness of the holes in the same, and the barbed points on the gold wire, when properly packed and vulcanized, will give ample strength and firmness to the case, and if care has been used in the entire manipulation, you will have, when finished, but a thin line of rubber exposed to view.

"In partial cases, if of gold base, solder on loops, as before, for the retention of the teeth; and if there are to be any clasps, make them of rubber, uniting them, as the teeth, with loops. If the ordinary plate teeth are used, it is frequently necessary to back them to give better retaining-points for the rubber. If blocks are to be burned, insert loops of platinum plate in the shape of the letter U in place of the platinum wire pins. In consequence of the affinity of the sulphur in the vulcanite for silver, plates of that metal should not be used."

Another method of increasing the attachment between the metallic base and the rubber, is that of spurring the plate over the ridge with a sharp-pointed chisel, as shown in Fig. 153.

When aluminium is employed as the base, the strongest and altogether the best means of increasing the attachment is that of cutting or punching loops from the plate itself, as shown in Fig. 154. Probably the best instrument for this purpose is that devised by Dr. J. H. Gaskill, which is illustrated in Fig. 155.

When a cast metal plate is employed, loops or pins are not needed, as sufficient anchorage is secured by cutting out the wax on the labial surface and from between the teeth (in fact, from every point where it is desirable to have the rubber) *before flasking for the casting process.* After the plate has been cast and finished, the rubber may be packed and the case reflasked, vulcanized, and finished in the usual manner.

The following unique and original method of casting a metal base-plate, fastenings, and hooks, in a single piece, is thus described by Dr. Norman W. Kingsley: "The plate is formed of a thin sheet of wax set up on the plaster model, but before it is flasked for casting I take a dozen small gimp tacks, with half round heads, and set

them in a row upon the ridge of the lower jaw, with their heads just imbedded in the wax, and then flask the piece. In flasking it, I use plaster and sand, in the proportions of about three parts of sand to one of plaster. This gives a fine surface when it comes in contact with the wax in making the mold, and it is sufficiently porous to dry out quickly. When the flask is opened, the wax is readily removed; the tacks are pulled out, and when the casting

FIG. 153.

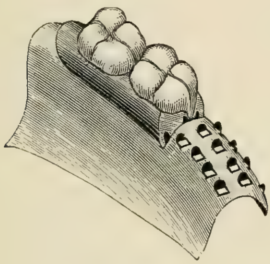


FIG. 154.

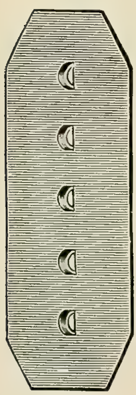
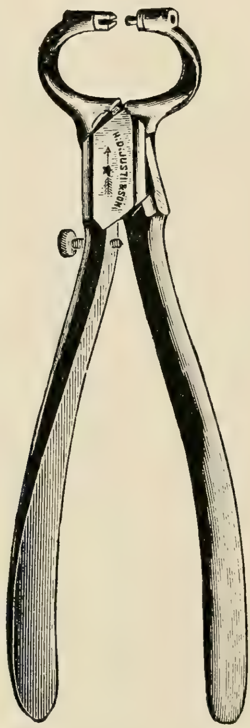


FIG. 155.



is made, the spaces that were occupied by the tacks are filled with the metal, so that we have a plate with a row of tacks of the same metal, which can be easily bent for attachments, standing around upon it."

If gum sections are used in connection with a plate formed in the manner just described, vulcanite may be employed as a means of attachment, but plain, single teeth are equally admissible in the

use of either rubber or celluloid. The particular alloy used by Dr. Kingsley in casting plates, and of which he speaks in terms of high commendation, consists of pure tin and bismuth, in the proportion of one pound of the former to one ounce of the latter.

The following method of preparing aluminium plates for the attachment of the rubber was communicated to the author by Dr. J. W. Hollingsworth, of Greencastle, Indiana, an intelligent practitioner who has had long and extended practical experience in the various modes of working this metal for dental purposes, and who says of the following mode of procedure that " it is the most practicable and the most easily manipulated method that I have yet seen."

The following is the manner of preparing the plate as described by Dr. Hollingsworth: " Perforate the ridge of the plate at proper points and intervals; then pass through these perforations, from the inner surface of the plate, headed pins made of aluminium, which, after replacing the plate with the pins back upon the die, we shrink down to permanency with a hollow punch. The punch must be made with the hole not quite equal in depth to the length of the extruding portion of the pins and slightly bell-mouthed. The riveting process forms seriate studs or pins, which may be bent or flattened with pliers in any way to suit the requirements of the case."

When celluloid is used for purposes of attachment in the case of full upper dentures, the palatal portion of the blank should be cut or sawed away, leaving only the ridge portion to be used, and this should be trimmed, if necessary, so as to have but little excess of material. The ordinary full blank may be used for lower cases, observing the same precautions in regard to quantity of material. When the blank is thus prepared, the subsequent manipulations are the same as those described in connection with the celluloid base.

It may be observed that, when rubber or celluloid is used, it is better to dispense with the plaster model in forming the mold or matrix, and proceed as follows: When the teeth are arranged, and the required contour and fullness given to the wax drafts, fill the lower section of the flask with plaster, and, having also filled the plate with the same, imbed the plate in it, making the dividing line on the external rim of wax. When the plaster has hardened, and the other section formed, and the two afterward separated, the

metallic plate will remain in the lower section and the teeth in the upper.

When using celluloid, plain teeth may be advantageously employed, the former representing the gum; this gives perfect freedom in the arrangement of each separate tooth in the denture, an optional disposition the importance of which cannot be over-estimated.

CHAPTER XXVI.

CAST METAL BASE.

Cheoplastic Process.—The method of mounting artificial dentures by what is familiarly known as the "cheoplastic process," in which the base consists of certain metallic compounds or alloys in cast form, has comparatively but limited application in prosthetic practice. The method, as commonly practised, is rarely applied to full upper cases, occasionally to partial upper pieces, but chiefly to lower dentures in cases of unusual absorption of the alveolar ridge, requiring increased weight to secure adequate stability of the substitute. The alloys in most general use for this purpose are those compounded by Drs. Wood, Weston, and Watt, whose names are a sufficient guarantee of the suitableness of those several alloys for the purpose.

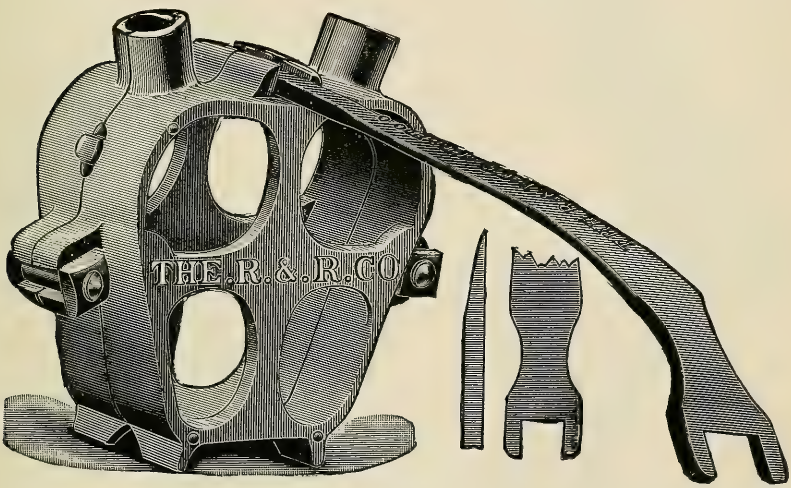
The construction of a denture by this method is readily accomplished by any one familiar with the working of vulcanite or celluloid. The manipulations concerned in the formation of a mold or matrix are, in general, the same as those employed in forming a matrix for rubber or celluloid. The model and investing material, however, must be of such substances as maintain their integrity of form perfectly under the heat necessarily applied in thorough drying of the case and contact of molten metals. Simple plaster, on this account, is unsuitable, either for the model or investment, and it is customary, therefore, to add to it, in relatively large proportions, such substances as undergo but little, if any change of form when exposed to the necessary heat. Those most commonly employed are finely-pulverized pumice-stone, marble-dust, soapstone powder, or clean white sand. In the use of any of these substances, only enough plaster should be added to give to the molding material sufficient body or strength necessary to provide against defacement in handling; say one part plaster to three of sand, which is the mixture generally employed.

One of the best adapted flasks for molding and casting purposes,

contrived by Prof. George Watt, is exhibited in Fig. 156. The piece, properly prepared by careful contouring of the wax or paraffin, is then flasked in the same manner as when preparing a mold for vulcanite. When the sections of the flask are separated, grooves or gateways should be cut, extending from the posterior and lateral margins of the mold to the openings on either side, shown in the figure, thus providing for the ingress and egress of the melted metal when poured; after which all traces of wax should be thoroughly washed out with boiling water.

The sections of the flask are now adjusted to each other, and tightly clamped, to prevent the escape of metal when poured.

Fig. 156.



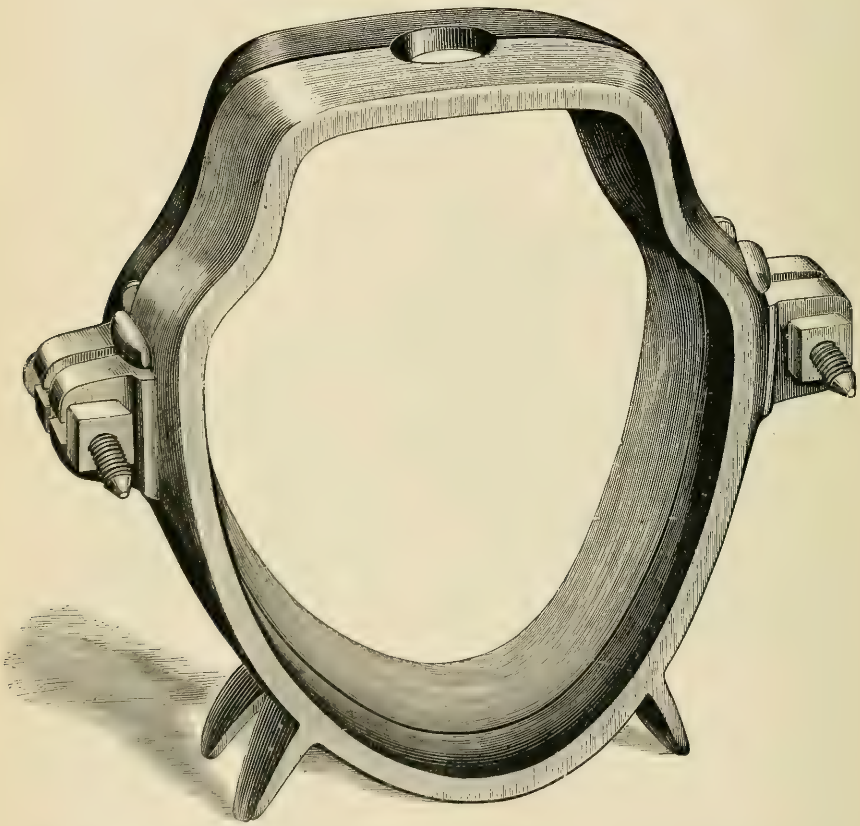
Before casting, the mold should be thoroughly dried by exposing it for two or three hours to an oven heat, and the temperature, at the moment of pouring, should be raised to about that required to fuse the alloys mentioned, or about 400° to 440° F.

In pouring the metal into the mold through one of the lateral openings, the metal should rise freely and quickly into the opposite one, and if bubbling occurs, which will never happen if the plaster has been sufficiently dried, the flask should be lightly tapped on some hard surface until the ebullition ceases, thus insuring a more certain intrusion of the metal into all parts of the mold before solidification takes place.

Dr. Weston has devised a casting flask (Fig. 157), the two sections of which form an encircling band with the sides, or top and bottom, open, and which are closed securely with screw-bolts. This form facilitates the escape of moisture from the plaster investment in the process of drying.

When the piece is quite cold, it may be readily removed from

Fig. 157.



the flask by soaking the investing material for a few minutes in water.

All superfluous metal is removed with suitable instruments, and all surfaces except the palatal face smoothed and polished, first with Scotch stone or fine emery cloth, and finally with chalk used upon a brush wheel.

If there are any narrow spaces or interstices, not affecting the integrity of the plate, that are not completely filled at the time of casting, such imperfections, Dr. Kingsley suggests, may be readily and perfectly repaired with amalgam.

There are other practicable methods by which cast metallic plates may be utilized to advantage, and their application to the needs of the practitioner greatly extended. There are many cases of absorption in which a lower denture constructed entirely of cast metal would be objectionable on account of excessive weight. In such cases, a plate of sufficient thickness to secure the required stability may be cast, and the teeth subsequently attached with rubber or celluloid, as described in connection with swaged plates; or the base-plate may be cast in the form of the rubber base described in connection with the new mode continuous gum, and faced in the same manner with celluloid—either method, while securing the requisite weight, admitting also of the use of single plain teeth.

GOLD ALLOY CAST BASE.

The compound of gold, silver, and tin, in varied proportions, in connection with specific and original methods of casting dental plates, devised and patented by Dr. George F. Reese, of Brooklyn, N. Y., has attracted attention as a possible substitute for the plastic vegetable substances so commonly employed as a base for artificial dentures.

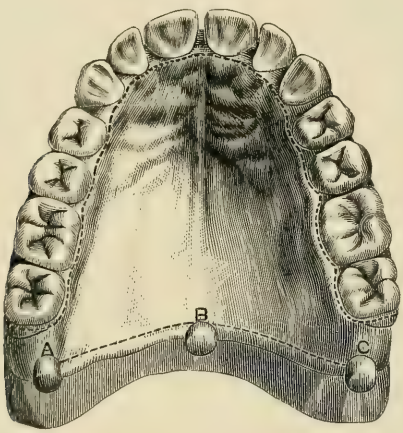
After premising that the methods in common use for casting alloys were not applicable to one having the molecular properties of Reese's compound, the inventor says he was led, after multiplied experiments, to adopt the plan of which the following is a description:

The impression is taken with plaster, to which salt or sulphate of potassa has been added, and the model obtained from this with pure plaster. Upon this the teeth are arranged. For the trial plate, gutta-percha, paraffin, and wax, or modeling compound, may be used. When satisfaction in the occlusion is obtained, then the case is returned to the model, and the waxing around the labial and buccal borders of the teeth completed. That portion of the trial plate which covers the palatine surface is now removed, so that the pins of the teeth will be nearly exposed, allowing the wax

which is under the gum to remain. That the plate, after casting, shall not be too cumbrous, the trial plate, which has been removed, must be substituted with two thicknesses of French flower wax, cut carefully to the model, and pressed down closely with the finger in such a manner that no wrinkles will appear to mar the beauty of the work.

Fig. 158 represents a case thus prepared. The dotted lines show the borders of the thin wax. B, A, and C, represent nipples of solid wax, fixed to the posterior border and to the tuberosities, A and C being the places of exit for the molten metal into the waste

FIG. 158.



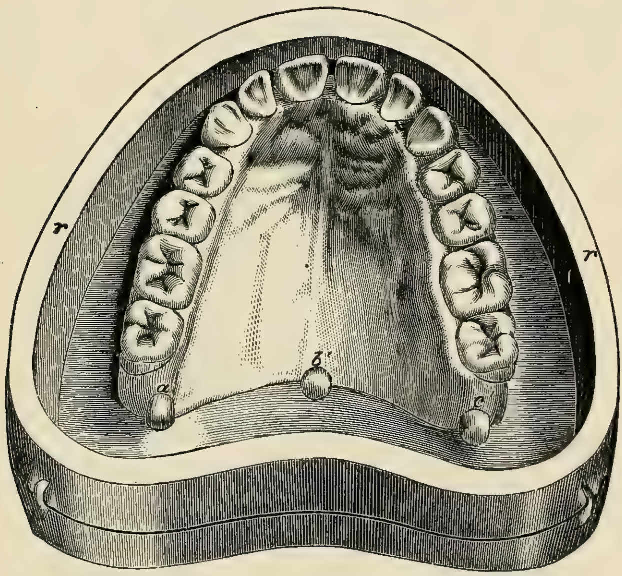
pockets, and B the place of entrance of the metal from the pouring-gain.

The case is now transferred to the small brass flask, *r*, Fig. 159, the sections of which have been well oiled upon the inner surface, to facilitate their removal from the investment. Either section is then placed upon a plate of glass and plaster poured into it until half filled. The model, as prepared, after being well saturated with water, is imbedded in this single section, allowing the teeth and gums to remain uncovered. Set on the counterpart of the flask and add more plaster along the posterior border until the nipples are reached or slightly covered. After this has set, the upper section may be removed and the surface of the plaster covered with a thin varnish or soapy water. Return the section

and complete the investment. Fig. 159 shows the case thus made ready.

After a proper time place the flask in hot water, that it may be separated without injury. When separated, wash away all the wax, and, by means of gentle tapping, remove the flask rings from the investment and set them aside. The depressions formed by the nipples may now be extended through the plaster to the external edge; or, if the circumstances of the case make this impossible, the channels may be made at the line of division between the two

FIG. 159.

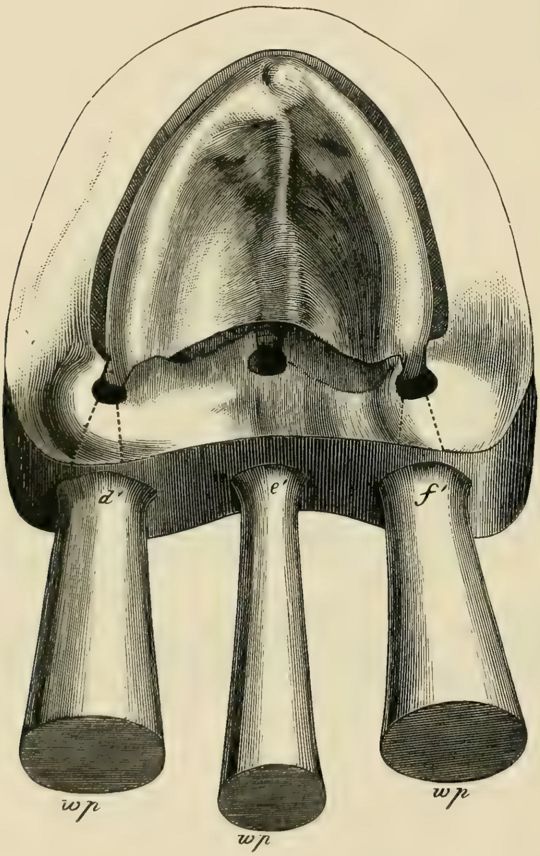


Case Ready for the Completion of Investment.

sections, as shown by the dotted lines in Figs. 160 and 161. Externally, the channels, D, E, F, Fig. 161, should be neatly countersunk and varnished with shellac to receive the pockets. The latter are made of the French wax by warming and wrapping the same around a cone-shaped stick and the base and apex of the cone neatly trimmed of all inequalities. These pockets should be about 1½ inches long, and about ½ of an inch in diameter at the base, and ⅛ of an inch at the apex. The pouring-gain is made in the same manner, but should be smaller in diameter at the base

and about two inches long. After removing these wax covers from the molding sticks, the larger ends of each should receive a thin wax cover secured to its place, and made water-tight by flowing hot wax along the line of junction, after the manner of soldering. Trim the covers, then place the smallest ends of the large cones

Fig. 160.



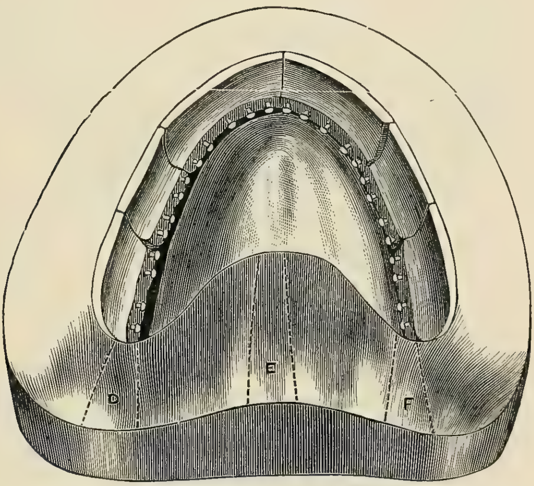
in the countersunk channels at the tuberosities and the small cone in the middle hole, and secure them with melted wax. Fig. 160, *d′*, *e′*, *f′*, shows the pockets thus attached.

Should the channels have been made through the solid plaster of the lower section, as in Fig. 160, then the upper section, Fig. 161, need not be joined to it until after the pockets are secured to

their places. Should, however, the channels have been made upon the line of division, then the sections must be joined before the pockets can be attached.

The case is now ready for a second investment, which is done in a flask sufficiently large to embrace the case as it now presents. Fig. 162 represents the construction of the large flask. One section of the same is placed upon glass and about half filled with plaster. The case, having been well soaked with cold water, is laid carefully upon the plaster, allowing the long cone to rest in the notch at the

Fig. 161.



Upper or Counter Section corresponding to Fig. 160. D, E, F, channels for entrance and exit of metal.

heel of the flask, and the waste pockets to become imbedded in the plaster. Immediately put the other section of the flask in place and complete the investment by filling with plaster the uppermost section to fullness. Of course, there will be no division of the sections, as was the case in the former flasking. After solidification, the pouring-gain must be neatly trimmed and countersunk, and great care must be exercised that no dirt be allowed to enter the channel.

The wax, which is imbedded in the plaster, and which forms the waste pockets, will be entirely absorbed, and no trace of it will be seen upon opening the flask.

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FIG. 162.

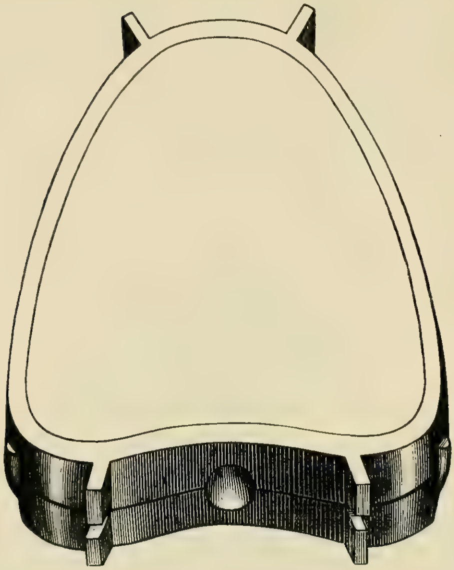
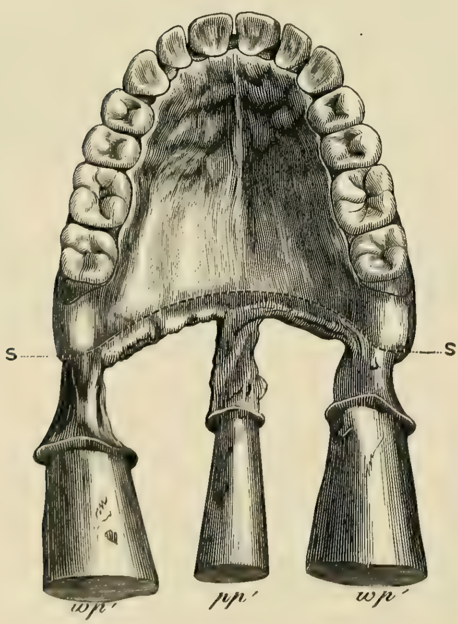


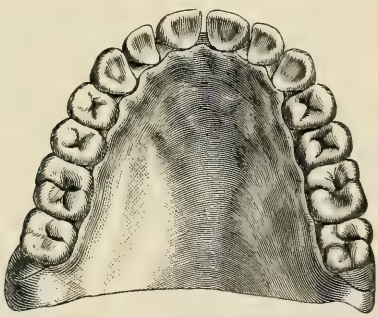
FIG. 163.



All is now ready for drying. This is done in an oven specially prepared for the purpose, but it may be accomplished in any way to be chosen by the manipulator. An ice-cold mouth mirror placed over the opening of the pouring-gain will detect the slightest moisture which may remain, and until this is entirely dispelled the casting should not be attempted.

There are several grades of the gold alloy, as compounded by Dr. Reese, to melt which require a heat registering from 600° to 700° F., but a higher temperature than this must be attained before pouring, in order to secure a satisfactory flow. At 900° rapid oxidation takes place. This, of course, should be avoided. The alloy may be melted in an ordinary iron ladle or crucible, over a gas or other flame, and should be poured while the mold is hot.

FIG. 164.



After the lapse of an hour or two, or until the cast is sufficiently cooled to insure the integrity of the teeth, it may be placed in warm water, when the investment can be easily removed.

Fig. 163 represents the cast after removal. The surplus metal may be separated along the dotted line S, with a ribbon saw, after which the denture is ready for the pumice wheel and brush. Fig. 164 represents the finished case.

Repairing.—The process of repairing broken plates is, in principle, the same as above. A flask, specially constructed by the inventor, is used for this purpose, whereby a single investment suffices. Suppose, for example, a plate is broken, from the labial to the posterior border, along the median line; the broken edges are scraped clean, and a separation made of about ⅛ of an inch. The parts are then adjusted upon the model, and the space between the

approximate edges filled with wax. At each extremity of the fissure a pencil of wax, ⅛ of an inch in diameter, and 1½ inches long, is securely attached, perpendicularly, to the palatal surface, and the whole surrounded with plaster to the depth of one inch. Thus will be constituted two sections, which are separated, and the wax washed out. The external ends of the channels, formed by the pencils, are then countersunk, and into each is inserted a wax cone, the one forming a pouring-gain and the other a waste pocket. The latter should be entirely covered by the plaster. The whole is now invested in the repair flask, and subsequently submitted to the process of drying.

Dr. W. S. Elliott, of New York, has taken advantage of the method above described to overcome the difficulties attending the construction of continuous-gum work.

To maintain a perfect adaptation of a swaged plate seems almost impossible, in consequence of the springing of the plate in the furnace. To avoid this difficulty, the following plan is suggested: The plaster model is first covered with two thicknesses of French flower wax, carefully adjusted. From this a metallic die and counter-die are made, and a very thin (No. 32) platina plate is swaged to fit the waxed model. The labial border need not be returned, as in ordinary cases. Upon this the teeth are arranged, and the case is transferred to the furnace for biscuiting and enameling. After proper annealing, it is replaced upon the model and waxed up, on the labial and buccal borders, over the edge of the plate, then flasked, the wax removed, and the metal cast upon it in the manner heretofore described.

Danger of checking the enamel is associated with the process; but success has attended the effort, and it is hoped that further experiments will insure perfect and uniform results.

CHAPTER XXVII.

DEFECTS OF THE PALATAL ORGANS AND THEIR TREATMENT BY ARTIFICIAL MEANS.

Palatine Defects.—Defects of the palatine organs may be divided into two classes, viz., accidental and congenital. The first includes all loss of substance in either hard or soft palate by disease or otherwise. Such defects are not uniform in locality or extent, being sometimes but a simple perforation of the palate, and at others involving the destruction of the entire soft palate, a considerable portion of the hard palate, the vomer and turbinated bones, and the loss of the teeth.

The second class includes all malformations, from the simple division of the uvula to an opening through the velum, palatine and maxillary bones, and a division of the upper lip, thus uniting throughout their entire extent the nasal passages with the oral cavity.

These malformations are quite similar in character, but not uniform in extent. They may be said to begin with the uvula, and in the uvula and velum *always occupy the median line;* but as the defect progresses anteriorly, it may deflect to one side or the other of the vomer, and follow the nasal passage through the lips, leaving the vomer articulated with the palate bone on one side; while in other cases the deformity seems to follow the median line, and thus involves both nasal passages and terminates in a double fissure of the lip.

In both cases, accidental and congenital, the faculty of distinct articulate speech is seriously impaired by defects of any extent. In ordinary cases of congenital deformity, deglutition is not materially interfered with. The patient, having never known any other method of swallowing, is not conscious of any difficulty. Accidental lesions, however, coming generally in adult life, produce, in this respect, very great inconvenience. The remedy for these evils must be the closing of the abnormal passage by

some means which will restore the functions to the deformed organs. In perforations of the hard palate, unless of extraordinary extent, the method is very simple. In the loss of the soft palate by disease the remedy is more difficult, and in extensive congenital deformity still more complicated appliances will be required.

As we have classified the defects, we shall also classify the appliances used for their remedy.

The term *obturator* will be used for all appliances intended to stop a passage, or all openings in the hard or soft palate which have a complete boundary. Appliances made to supply the loss of the posterior soft palate, whether accidental or congenital, will be called artificial vela, or palates.

Obturators.—Any unnatural opening from the oral cavity into the nasal cavity, which will permit the free passage of the breath, will impair articulation. Any appliance which will close such passage, and can be worn without inconvenience, will restore articulation.* Obturators were formerly made of metallic plate, gold or silver being most commonly employed, and many very ingenious pieces of mechanism were the result of such efforts, but latterly vulcanized rubber has almost entirely superseded the use of metals. Vulcanite has been found preferable to metals, being much lighter and much more easily formed and adapted, particularly when of peculiar shape.

The steps to be taken in the formation of an obturator are not unlike those used in making a base for artificial teeth. It is essential that an accurate model be obtained of the opening, the adjacent palatal surface, and the teeth, if any remain in the jaw. For this purpose an impression in plaster is the only reliable means for such an end. Care must be used that a surplus of plaster is not forced through the opening, thus preventing the withdrawal of the impression by an accumulated and hardened mass larger than the opening through which it passed. To avoid this, beginners or timid operators had better take an impression in the usual manner with wax; if this is forced through, it can be easily removed,

* The student will bear in mind that no cognizance is here taken of openings similar to those described in cases of congenital fissure, where the surgeon has united the soft palate, and left an opening through the hard palate, to be covered by an obturator. In such cases, neither the surgeon's operation nor the obturator will prove of much advantage.

without injury to the patient. From this wax impression make a plaster model, and upon this form an impression-cup of sheet gutta-percha, with a stick, piece of wire, strip of metal, or any other convenient thing for a handle. This extemporized impression-cup must not impinge upon the borders of the opening, neither should it enter to any extent. With a uniform film of soft plaster, of from $\frac{1}{16}$ to $\frac{1}{8}$ of an inch in thickness, laid over this cup, a correct impression can be made without any surplus to give anxiety. Upon a correct plaster cast, taken from such an impression, make a model of the obturator out of gutta-percha, thin sheets of modeling compound, or other plastic substance; the subsequent steps being in principle the same as in making any other piece of vulcanite. It is desirable that it should enter the perforation and restore as far as possible the lost portion of the palate, but it must not protrude into or in any way obstruct the nasal passage.

The entire freedom of the nasal passage is essential to the purity of articulation.

That portion of the obturator which occupies the oral cavity should be made as delicate as possible, consistent with its strength and durability.

A clumsy contrivance will interfere with articulation almost as much as it is improved by stopping the opening; therefore, if the obturator could be confined entirely to the opening, like a cork in a bottle, it would be all the more desirable, but as it cannot, resort must be made to clasping to the contiguous teeth, if there are any, and if not, the obturator must spread out over the whole jaw, and receive its support in the same manner as would a set of artificial teeth. In fact, this is just what it would become in such a case, viz., an upper set of teeth bridging over and filling up an opening in the palate, thus combining an obturator with a set of teeth.

Kingsley's Obturators and Methods of Procedure.—The following descriptions, with accompanying illustrations, were contributed to this work by Professor Norman W. Kingsley, who excels in the practice of this difficult and important specialty of the dental art.

Fig. 165 represents an obturator without teeth and without clasps, for a perforation of the hard palate, being sustained *in situ* by impinging upon the natural teeth with which it comes in contact. Accuracy of adaptation and delicacy in form are all that is

essential in such cases, and the restoration of the speech will follow immediately.

Fig. 166 represents a more complicated obturator, adapted to an opening in the soft palate.

The necessity for a variation in the plan will be found in the anatomical fact of the constant muscular action of the soft palate, which would not permit, without irritation, the presence of an immovable fixture.

This is contrived, therefore, with a joint that will permit the part attached to the teeth to remain stationary, while the obturator proper is carried up or down as moved by the muscles. The joint, *A,* should occupy the position of the junction of the hard and soft palates. The joint and principal part of the appliance is

Fig. 165.

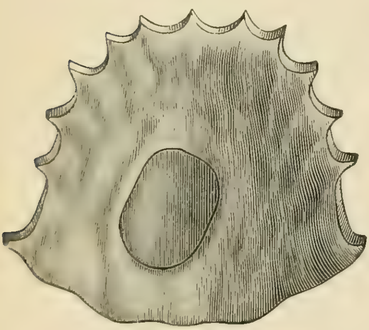
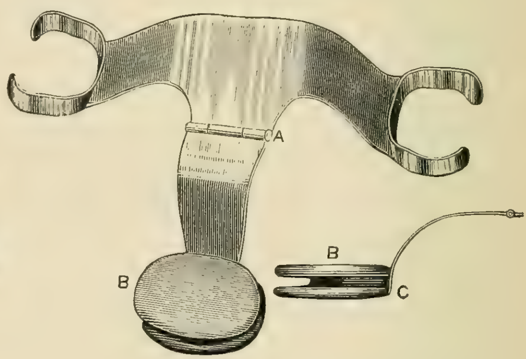


Fig. 166.



made of gold, the obturator of vulcanite. The projection, *B,* lies like a flange upon the superior surface of the palate and sustains it; otherwise the mobility of the joint would allow it to drop out of the opening. This flange is better seen in the side view marked *C.* It is readily placed in position by entering the obturator first, and carrying the clasps to the teeth subsequently.

Figs. 165 and 166 will illustrate the essential principles involved in all obturators. The ingenuity of the dentist will often be taxed in their application, as the cases requiring such appliances all vary in form and magnitude.

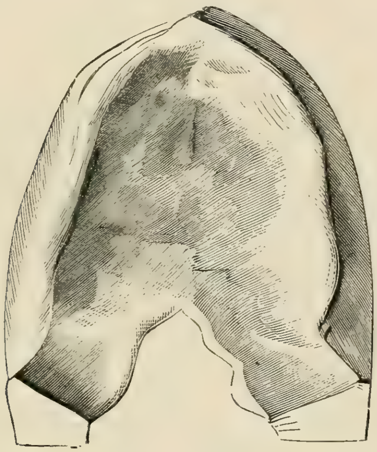
Artificial Palates.—Before proceeding to a description of appliances, a brief reference to the anatomical relations and functions of the palate will be necessary. The palate exercises quite

as important an office in the articulation of the voice as does the tongue or lips. Being a muscular and movable partition to separate the nasal and oral cavities, one edge is attached to the border of the hard palate, while the other vibrates between the pharynx and the tongue. The voice, therefore, as it issues from the larynx, is directed by the palate entirely into the mouth, or through the nose, or permitted to pass both ways.

A very slight deviation in this organ from its natural form will make the voice give a different sound. So will, also, the presence of anything that clogs the natural passages, either oral or nasal.

Place any obstruction in the nasal passages, paralyze the soft

FIG. 167.



palate, or let it be deficient in size, and the power of distinct articulation is wanting.

The evidence of this statement is frequently found after the surgeon has successfully performed the operation of staphylorrhaphy in cases of congenital fissure.

In such instances, with rare exceptions, the newly formed palate is so deficient in length, and so tense, as to be deprived of its function. It cannot be raised so as to meet the pharynx and shut off the nasal passage, but hangs like an immovable septum to divide the column of sound.

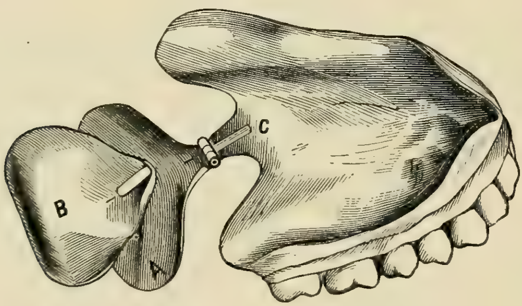
Fig. 167 represents a defective palate belonging to the first class, the uvula and a portion of the soft palate contiguous being de-

stroyed by disease. In such a case an obturator would be useless; the constant activity and the surrounding parts would not tolerate it. The material used for a substitute must be soft, flexible, and elastic, and the elastic vulcanite is admirably adapted to this purpose.

By observing the cut (Fig. 167) it will be seen that a portion of the soft palate along the median line remains, and consequently there will be considerable muscular movement which must be provided for, and which may be taken advantage of. It is desirable to make this movement available in using an artificial palate, as thereby more delicate sounds are produced than otherwise.

This case presents some extraordinary difficulties in the fact that all the teeth of the upper jaw have been extracted, and it was

FIG. 168.



necessary, therefore, to adopt a plate which should not only sustain teeth for mastication, but bear the additional responsibility of supporting the artificial palate. In the choice of material best adapted for the base for the teeth in such instances, it is preferable to adopt that which will prove the most durable. There are too many interests involved to risk the adoption of anything but the best. In the case under description, the patient desired duplicates, and two sets of teeth were made, one on gold and the other on platina, with continuous gum.

The plates were made like other sets of teeth, with the exception of a groove located on the median line at the posterior edge to receive the attachment for the palate (marked C, in Fig. 168).

Fig. 168 will indicate the set of teeth with palate attached. The wings marked letters A and B are made of soft rubber; the frame

to support them is made of gold, with a joint to provide for the perpendicular motion of the natural palate, as in the case of the obturator represented in Fig. 166.

When the artificial palate is in use, the joint and frame immediately contiguous lie close to the roof of the mouth; the rubber wing, letter A, bridges across the opening on the inferior surface, or side next the tongue; the wing, letter B, bridges across the opening on the superior or nasal surface, and is also prolonged backward until it nearly touches the muscles of the pharynx when they are in repose.

Both these wings reach beyond the boundary of the opening and rest on the surface of the soft palate for a distance of from 1/8 to 1/4 of an inch, thus embracing the entire free edge of the soft palate. This last provision enables the natural palate to carry the artificial palate up or down, as articulation may require.

When the organs of speech are in repose, there is an opening behind the palate sufficient for respiration through the nares. When these organs are in action, a slight elevation of the palate, or a contraction of the pharynx, will entirely close the nasal passage and direct all the voice through the mouth. The palate thus becomes a valve to open or close the nares, and to be tolerated must be made with thin and delicate edges which will yield upon pressure. An instrument thus made will restore, as far as is possible by mechanism, the functions of the natural organ.

In the case under description the patient was a lady; the defect had existed for seven years before remedy. Articulation was very defective; distinct and perfect articulation followed within one month.

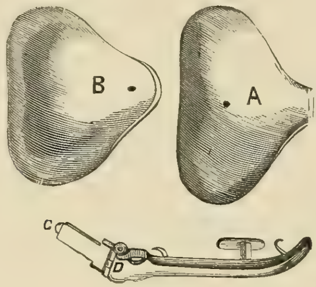
Fig. 169 represents the artificial palate separated into its constituent parts. The frame is bent at the joint, in the engraving, to show a stop, marked D, which prevents the appliance from dropping out of position. Letter C shows the tongue, which enters the groove in the plate of teeth and connects them. Letters A and B are the rubber flaps, which are secured to the frame by the hooks, as seen in the engraving.

The process for making the rubber wings will be found described on page 385.

Fig. 170 shows a more extensive palatine defect of the first class. In this case the entire soft palate is gone, together with a small portion of the hard palate at the median line.

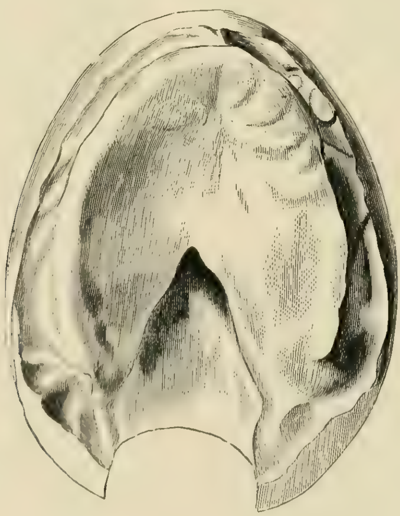
Although this defect is greater in extent, the means for its remedy are more simple. The muscles of the palate are entirely gone, and consequently no perpendicular movement need be provided for.

Fig. 169.



The appliance in this case will resemble an elastic obturator more than the valve-like palate of the preceding one. The principle here adopted will be substantially that recommended by Mr. Sercombe, of London, and consists of a plate with a set

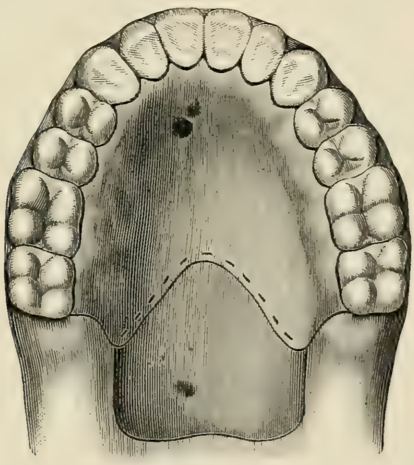
Fig. 170.



of teeth in the usual form, and attached to its posterior edge an apron of soft rubber, which shall bridge the opening on its inferior surface, extending nearly to the pharynx. Fig. 171 repre-

sents the set of teeth with the palate attached. In Mr. Sercombe's appliance this apron was made of the common sheet rubber in the market, prepared for other uses, and is objectionable for two reasons: First, a want of purity in the materials of which it is compounded, in many instances substances being used in its manufacture which would prove deleterious to the health of the patient; and, second, its uniformity of thickness. It is far preferable, therefore, to make a mold which will produce a palate of pure and harmless materials, and which shall be of sufficient thickness in the central part, and at its anterior edge, to give it stability, and shall have a thin and delicate boundary wherever it comes in contact with movable

FIG. 171.



tissue. Such a palate may be made in a mold by substantially the same process as hereinafter described. (See page 386.) It may be secured to the plate by a variety of simple means. One, which will give as little trouble to the patient as any other, is to make a series of small holes along the edge of the plate and stitch it on with silk; or fine platina, gold, or silver wire may be used.

It is desirable to have the plate and palate present a uniform surface on the lingual side. In fitting the plate, therefore, it may be raised along the posterior edge from $\frac{1}{16}$ to $\frac{1}{10}$ of an inch, according to the thickness of palate desired. The rubber will thus

be placed on the palatine surface of the plate and present uniformity on the lingual surface.

A little thought will show that in this case the patient must educate the *muscles of the pharynx alone* to do the work of shutting off the nares, which in the former case was performed by them in conjunction with the muscles of the palate. Perfection of articulation will therefore depend upon the success of the patient in this new use of these muscles.

In cases of accidental lesions of the palate, such as are under consideration, this education of the muscles to a new work will not be difficult. The patient at some former time has had the power of distinct articulation; his ear has recognized in his own voice the contrast between his present and former condition; the ear will therefore direct and criticize the practice until the result is attained.

In the case illustrated by Figs. 170 and 171, the defect had existed for twenty-eight years, the patient at the time of the introduction of the artificial palate being nearly fifty years of age. The effect upon the speech was instantaneous. Articulation was immediately nearly as distinct as in youth, and this remarkable distinctness can only be accounted for upon the assumption that the pharyngeal muscles had undergone a thorough training in the vain effort to articulate without any palate.*

The two cases chosen to illustrate the application of artificial palates in accidental lesion have required, as will have been perceived, entire upper sets of artificial teeth in connection with the palates. This selection was purposely made, because the difficulties to be overcome are much greater. In cases where there are natural teeth remaining in the upper jaw, the palate and its connection with a plate would be substantially the same, and the plate might easily be secured to the teeth by clasps, in the same manner as a partial denture.

Artificial Palates for Congenital Fissure.—Congenital fissure of the palate presents far greater difficulties to be overcome than cases of accidental lesion. The opening is commonly more extensive, the appliance more complicated, and the result more prob-

* An account of this case appears in the *Argus*, of Bainbridge, Georgia, August 1, 1868, written by the patient himself, the editor of that paper.

lematic. Nevertheless, appliances have been made in a large number of cases which have enabled the wearer to articulate with entire distinctness, so much so as not in the least to betray the defect. The first efforts in this direction were of the character of obturators, simply plugs to close the posterior nares, and the results were far from satisfactory. It was not until it was recognized that the two classes of cases, accidental and congenital, were entirely distinct that much progress was made.

Nearly every case of accidental lesion can be treated with an obturator with considerable success; very rarely will an obturator be of any benefit in congenital fissure, even if the congenital and accidental case present substantially the same form of opening. For this reason so much mystification has been thrown around these appliances within a few years past. The character of the different classes has been confounded, and an instrument admirably adapted to one class has had claimed for it an equal application to the other class. Let it be understood, therefore, as a rule to which there will be but few exceptions, that congenital fissure of the soft palate requires for its successful remedy a soft, elastic, and movable appliance, and that when the most skilfully made and adapted instrument is worn, *articulation must be learned,* like any other accomplishment. Various inventions have been made for this purpose within the last twenty-five years, from the most complicated one of Mr. Stearns, described in the first edition of this work, to the extreme of simplicity of bridging the gap with a simple flap of rubber. The Stearns instrument, with all its complexity, embodied the only true principle, viz., the rendering available the muscles of the natural palate to control the movements of the artificial palate.

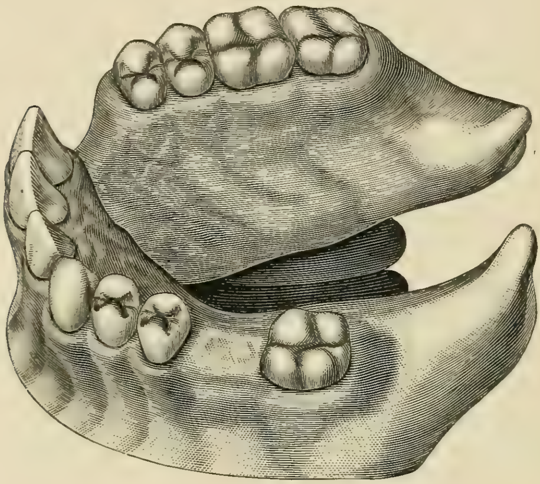
The essential requisites of an artificial palate will be to restore, as far as possible, the natural form to the defective organs with such material as shall restore their functions. Muscular power, certainly, cannot be given to a piece of mechanism, but the material and form may be such that it will yield to and be under the control of the muscles surrounding it, and thus measurably bestow upon it the function of the organ which it represents.

Fig. 161 represents a model of a fissured palate, complicated with harelip on the left side of the mesial line. There is a division, also, of the maxilla and the alveolar process, the sides being

covered with mucous membrane, which come in contact with each other but are not united. The left lateral incisor and left canine tooth are not developed.

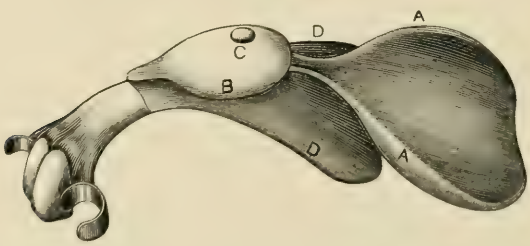
Fig. 173 represents the artificial velum, as viewed from its superior surface, together with the attachment and two artificial teeth to fill the vacancy.

Fig. 172.



The lettered portion of this appliance is made of soft vulcanized

Fig. 173.



rubber; its attachment to the teeth of hard vulcanized rubber, to which the velum is connected by a stout gold pin, firmly imbedded at one end in the hard rubber plate. The other end has a head, marked C, which, being considerably larger than the pin, and also

than the corresponding hole in the velum, is forced through—the elasticity of the velum permitting—and the two are securely connected.

The process, B, laps over the superior surface of the maxilla (the floor of the naris), and effectually prevents all inclination to droop.

The wings, A A, reach across the pharynx, at the base of the chamber of the pharynx, behind the remnant of the natural velum.

The wings, D D, rest upon the opposite or anterior surface of the soft palate.

FIG. 174.

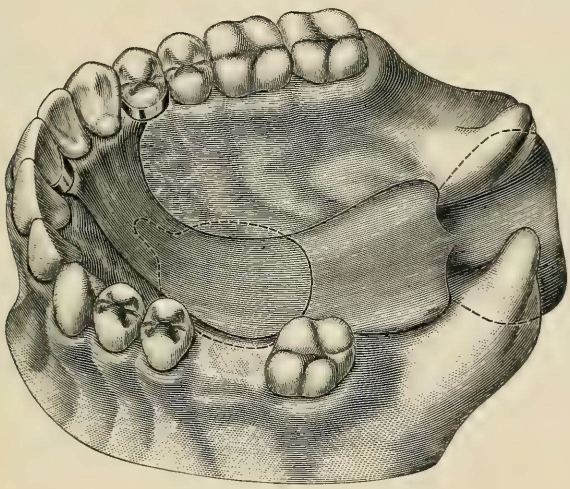


Fig. 174 represents a model, the same as Fig. 172, with the appliance, Fig. 173, *in situ.*

The wing, D D, in Fig. 173, and the posterior end of the artificial velum only in this cut being visible.

Method of Making an Artificial Palate.—The success of these appliances depends very much upon the accuracy of the model obtained to work by.

It is essential that the entire border of the fissure, from the apex to the uvula, should be perfectly represented in the model, as the parts are when in repose. It is also necessary that the model show definitely the form of the cavity above, and on either side of the opening through the hard palate, being that part of the cavity which

is hidden from the eye. It is desirable, also, that the posterior surface of the remains of the soft palate be shown, but this is not essential; but it is especially important that the anterior or under surface be represented with relaxed muscles and in perfect repose. The impression for such a model must be taken in plaster; it is the only material now in use adapted to the purpose. An ordinary Britannia impression-cup may be used, selecting one in size and form corresponding to the general contour of the jaw. This cup will be found too short at the posterior edge to receive the soft palate, but it may be extended by the addition of a piece of sheet gutta-percha, which must be molded into such form as not to impinge upon the soft palate, but which will reach under and beyond the uvula, and thus protect the throat from the droppings of plaster. Before using the plaster the posterior edge of the gutta-percha extension may be softened by heat and introduced into the mouth; contact with the soft palate will cause it to yield, so that there is no danger of its forcing away the soft tissues when the plaster is used. With the precaution not to use too much plaster, the first effort will be to get only the lingual surface. After trial, if the impression show definitely the entire border of the fissure, and the soft palate has not been pushed up by contact with the cup, nor pulled up by the spasmodic action of the levator muscles, it is all that is thus far desired. If, however, the soft parts have been disturbed (which on close comparison a little experience will decide), it is better to cast a model into the impression, and upon this model extemporize an impression-cup. This temporary cup will have the advantage of the former, insomuch that it will require but a film of plaster to accomplish the result, thus lessening the danger of disturbing the soft tissues. After the removal, if it is seen that any surplus has projected through the fissure and lapped out to the floor of the nares, it may be pared off.

The next step will be to obtain, in conjunction with this impression of the under surface, which we will call the palatal impression, an impression of the upper or nasal surface of the hard palate.

This can be done by filling the cavity above the roof of the mouth with soft plaster down to the border of the fissure, and while yet very soft carrying immediately the palatal impression against it, and retaining it in that position until the plaster is hard, which can easily be ascertained by the remains in the vessel from

which it was taken. With the precaution to paint the surface of the palatal impression with a solution of soap, to prevent the two masses from adhering when brought in contact, there will be no difficulty in removing it from the mouth, leaving the mass which forms the nasal portion *in situ*. With a suitable pair of tweezers this mass is easily carried backward and withdrawn from the mouth, and the irregular surface of contact indicates its relation to its fellow when brought together.

The method of obtaining the model of the jaw from the impression does not require any particular description. The process is similar to the making of a cast in any other mouth impression.

The model represented in Fig. 172 shows a convenient form for such a cast.

When the nasal portion of the impression does not indicate the superior surface of the soft palate, the part may be represented in the cast by carving. It is not essential to the success of the instrument to be made that the posterior surface of the soft palate should be represented with the same accuracy that is required of the inferior surface, or of both surfaces of the hard palate. By the aid of a small mirror and a blunt probe, the thickness of the velum and the depth behind the fissure can be ascertained, and the model carved accordingly.

The portion of the artificial palate coming in contact with it is so elastic that it easily adapts itself to a slight inequality, rendering absolute accuracy less important.

The next step will be the formation of a model or pattern of the palate. Sheet gutta-percha is preferable for this purpose, although wax, or many other plastic substances, might answer.

The form which should be given it is better indicated by the drawing, Figs. 173 and 177, than a written description would give. The complicated provision for the contraction of the fissure found in older forms of instruments is entirely superseded in these by making the appliance somewhat in the form of two leaves, one to lie on the inferior and the other upon the superior surface of the palate, and joined together along the median line. When the fissure contracts, the halves of the divided uvula slide toward each other between these two leaves. The posterior portion, marked A in Fig. 173, is made very thin and delicate on all its edges, as it occupies

the chamber of the pharynx and is subject to constant muscular movement.

The sides are rolled slightly upward, while the posterior end is curved downward. The inferior portion, marked D D, in Fig. 173, should reach only to the base of the uvula, and bridge directly across the chasm at this point, and no effort to imitate the uvula should be made. The extreme posterior end should not reach the posterior wall of the pharynx when all the muscles are relaxed by ¼ of an inch, although subsequent use must determine whether this space be increased or diminished, thus leaving abundant room for respiration and the passage of nasal sounds. In cases where it is desirable to make the instrument independent of the teeth, so far as possible, in its support, the anterior part, which occupies the apex of the fissure in the hard palate may lap over on to the floor of one or both nares. Such a projection is seen in Fig. 173, marked B, and a like process is seen in Fig. 177, but not lettered. Were it not for this process in this case, the palate would drop out of the fissure into the mouth, the single clasp at the extreme anterior end not being sufficient to keep the whole appliance in place throughout its entire length. Caution must be exercised that this projection entering the nares be not too large, or it will obstruct the passage and give a disagreeable nasal tone to the voice.

All these described peculiarities must be provided for in the gutta-percha model, which, after having been carefully formed to the cast, may be tried in the mouth to ascertain its length or necessary variations. When its ultimate form has been decided upon, provision must be made to duplicate it in soft rubber.

A parallel process, and one which will be a familiar illustration, is used when a set of teeth is made on vulcanite base. A model or pattern form is made of gutta-percha, bearing the teeth, and in all its prominent characteristics is shaped as the completed denture is desired, the rubber duplicate being vulcanized in a plaster mold. In like manner the rubber duplicate of the palate, as before described, may be made in a plaster mold.

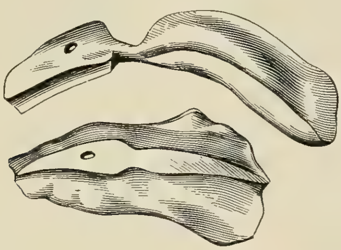
If plaster is used it must be worked with much care, so that the surface shall be free from air-bubbles, or the rubber palate will be covered with excrescences that cannot be readily removed. By covering the surface of the mold with collodion or liquid silex,

it will be much improved. But ordinarily plaster molds will be found too troublesome for general use. They may be put to a most excellent use, however, by using one to make a duplicate of the gutta-percha in hard rubber.

This is not necessary with those who have had much experience, but with beginners it will be difficult to work up the gutta-percha as nicely as may be desired; a duplicate of vulcanite will enable the operator to make a more artistic model of the palate, and one which can be handled with greater freedom.

As in the course of a lifetime a considerable number of elastic palates will be required, the mold which produces them should be made of some durable material. The type-metal of commerce is admirably adapted to this use. The most complete mold is one made of four pieces, which will produce a palate of one continuous

FIG. 175.



piece. Such a mold requires very nice mechanical skill in fitting all the parts accurately, and unless the operator has had experience in such a direction, it is better to simplify the matter. By making the palate in two pieces, to be joined after vulcanizing, the mold may be made in two pieces, and with very little trouble.

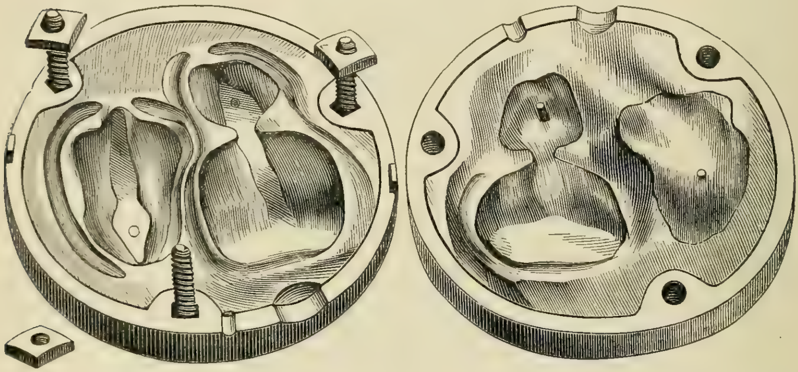
Fig. 175 shows a palate divided.

Fig. 176 shows the mold or flask in which it is vulcanized. These flasks were made expressly for this purpose, but they are not so unlike the flasks in common use in dentists' laboratories that the latter will not answer. The common flask is simply unnecessarily thick or deep.

The mold is really produced in the following manner: Imbed the two pieces of the palate in plaster, in one-half of the flask; when the plaster is set and trimmed into form, duplicate it in type-metal by removing the palate, varnishing the surface, molding in

sand, and casting. In making the sand mold, take a ring of sheet-iron of the same diameter as the flask and three or four inches high; slip it over the flask and pack full of sand. Separate them, remove the plaster, return the flask to the sand mold, and fill with the melted metal through a hole made in the side or bottom of the

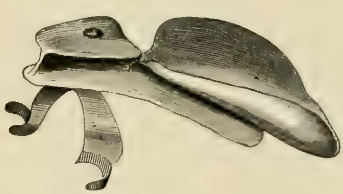
FIG. 176.



flask. With one-half thus made, substantially the same process will produce the counterpart.

Fig. 177 shows the palate complete, with its attachment to the teeth. The palate is secured to the plate by a pin of gold passing through a hole in the palate of the same size; the head on the pin,

FIG. 177.



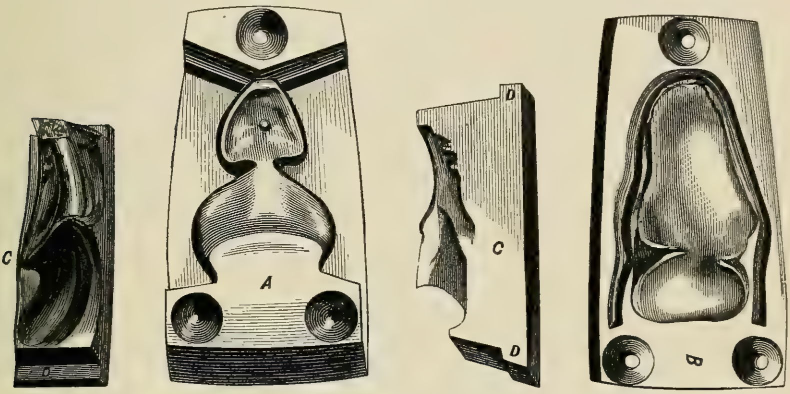
being larger than the hole, is forced through, and thus the two halves of the palate are bound together and joined to the plate.

Fig. 178 shows a mold in four pieces. The blocks, C C, are accurately adapted to the body of the mold, marked A, and are prevented from coming improperly in contact with each other by the flanges, D D, which overlap the rest upon the sides of the

main piece. B shows the top of the mold, and the groove, E, provides for the surplus rubber in packing.

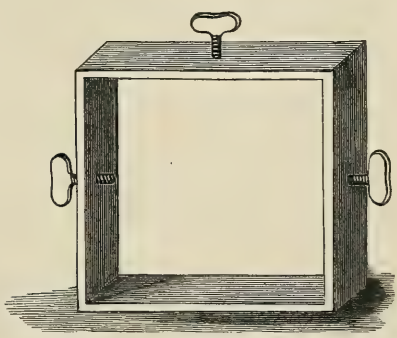
Such a mold makes the most perfect appliance that can be produced. The palate is one homogeneous and inseparable piece.

FIG. 178.



The cut will sufficiently indicate the forms of the several parts. Each of these pieces is first made in plaster of exactly the form of which the type-metal is desired. They are then molded in sand and the type-metal cast as in making an ordinary die for swaging.

FIG. 179.



When in use, a clamp similar to Fig. 179 is placed around the mold to keep the several parts firm in their position.

The packing of the mold with rubber will be done in the same manner as when hard rubber is used for teeth bases, with which

process it is assumed that the operator is familiar. By washing the surface of the mold with a thick solution of soap previous to packing, the palate will be more easily removed after vulcanizing.

The rubber used for this purpose must be a more elastic compound than that used as a base for teeth. The composition used for the elastic fabrics of commerce will answer if made of selected materials.

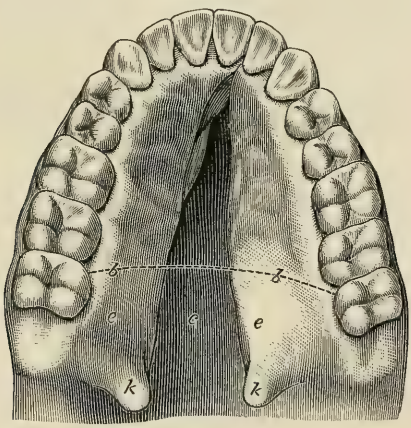
Suersen's Obturator.—Dr. Wilhelm Suersen, of Berlin, introduced an obturator, the principle of which has seemed to many the best for obtaining correct articulation. In describing it in *The American Journal of Dental Science,* he says:

"In order to be able to pronounce all letters distinctly, it is accordingly necessary besides other conditions, which are far away from our present subject, to separate the cavity of the mouth from the cavity of the nose by means of muscular motion. That separation is, under normal conditions, effected, on the one hand, by the velum palati, which strains itself (consequently by the levator and tensor palati); but, on the other hand, also, by a muscle which, to my knowledge, has, in connection with these operations, not yet received a sufficient amount of attention—I mean the constrictor pharyngeus superior. This muscle contracts itself during the utterance of every letter pronounced without a nasal sound, just as the levator palati does. The constrictor muscle contracts the cavum pharyngopalatinum, the pharynx wall bulging out; and it is chiefly on the action of this muscle that I base the system of my artificial palates.

"These palates, which in all their parts are made of hard caoutchouc, consist of a teeth-plate suitably attached to existing teeth, and which, at the same time, covers the fissure in the hard palate, if such a fissure exists. Where the fissure commences in the velum, that plates terminates in an apophysis broad enough for filling up the defect. This apophysis is at the same time of such thickness as to keep up a contact between the high edges forming the sides of the apophysis and the two halves of the velum, even when the levator palati is in activity. To bring about this contact the more surely, the high edges forming the sides do not rise straight, but obliquely, toward the outside. The lower surface of the apophysis, turned toward the mouth, lies on about an equal level with the velum *if the latter is raised by the levator palati.* But

when the velum hangs loosely downward, the back part of the artificial palate is lying over it. This back part, accordingly, fills up the cavum pharyngopalatinum, and in such a manner as not to impede the entrance of the air into the cavity of the nose when the constrictor pharyngeus superior is inactive. Thus the patient can without any impediment breathe through the nose. But as soon as the constrictor contracts the cavum pharyngopalati (this happens, as I will repeat for the sake of clearness, in the utterance of every letter with the exception of *m* and *n*), the muscle already named reclines against the vertical back surfaces of the obturator. By this operation the air-current is prevented from entering the cavity of the nose, and is compelled to take its way through the

FIG. 180.



mouth, and thus the utterance loses its nasal sound. To the existence of those vertical surfaces, and consequently to the thickness of that part of my palates which fills up the fissure in the soft palate and the cavum pharyngopalatinum, I must attach special importance. But for that thickness the levator palati, when it rises upward, would not remain in contact with the side edges of the obturator, nor would the constrictor pharyngeus be able to effect a sufficient termination if the portion of the obturator nearest to it consisted only of a thin plate."

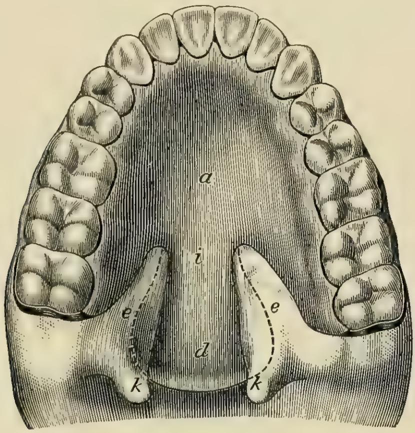
Fig. 180 represents the mouth without the apparatus.

Fig. 181 shows the apparatus in position; Fig. 182 gives a view of the appliance out of the mouth.

Dr. Henry Baker, in writing of this appliance in the "American System of Dentistry," says:

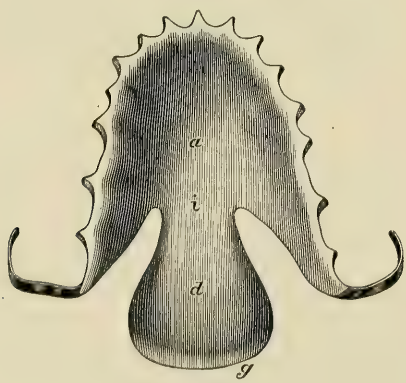
"The plate, *a*, and its narrow and thin apophysis, *i*, which ex-

FIG. 181.



tends from the boundary, *b*, of the hard palate to the commencement of the defect, *c*, in the soft palate, serve also as supporters to the real thick obturator, *d*. The latter lies in the pharyngopalatine

FIG. 182.



hollow, so that the lower surface of the obturator turned toward the mouth, is about on the same level as the rest of the velum palati, *e*. Against the vertical side, *f*, and back edges, *g*, of the

obturator the walls of the pharynx lean if the latter is contracted by a contraction of the superior constrictor of the pharynx. But if the muscle just mentioned is not in activity, the obturator does not touch the pharyngeal wall. The contraction of the constrictor superior, therefore, closes the valve formed, with the help of the obturator, between the cavity of the mouth and that of the nasal bone, while any relaxation of the above-mentioned muscle immediately reopens that valve. The thickness of the obturator begins where the fissure in the soft palate commences. With the high side edges of the fore part of the thick obturator, which edges ascend, not straight but obliquely, toward the outside, the side halves of the fissured velum palati, *e*, are in constant contact, even when the latter are raised by the action of the muscular levator palati. The proportions of the back part, which, in the same manner as in the case of an acquired defect, fill up the cavum pharyngopalati, *k k*, are the two halves of the fissured uvula."

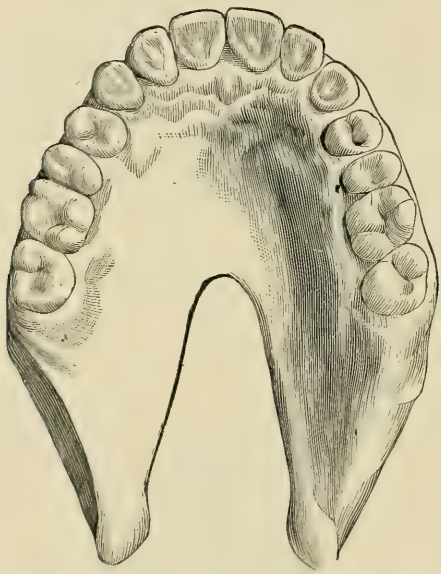
Dr. Suersen admits the importance of the part taken by the levator palati muscles in the formation of articulate speech; yet he makes no provision for utilizing them as such, and provides only for the contact of the superior constrictor muscle with the distal surface of the appliance to shut off the nasal passage. For the patient afflicted with congenital cleft, to acquire perfect articulation with such an appliance, even if it be possible, years of application and training of this muscle would be necessary; and a little reflection will show that this muscle, besides performing its own functions, must be trained to fulfil those of the velum palati, levator palati, and tensor palati. But in an *accidental* lesion this may be all that is necessary, as the patient having previously learned to articulate distinctly, and having this deformity come upon him afterward, the superior constrictor muscle would no doubt be sufficiently developed to perform that function. Sir William Ferguson, in his report of a dissection made by him of a cleft palate, in 1844, states distinctly that the constrictor was very full, and he also claimed for that muscle very decided forward action in deglutition.

Dr. Kingsley, in speaking of Suersen's appliance, says: "First, that of all obturators this is the best form for congenital fissure, but while the wearer is enabled to articulate with such an instrument, it is only after he has learned articulation with another ap-

paratus. Second, that a soft, elastic, artificial velum is much better adapted to the acquirement of articulation than any unyielding, non-elastic substance, but when acquired an obturator may be substituted. Third, that in very rare cases articulation may be acquired with an obturator only, but it is the extra activity of the pharyngeal muscles, while with the elastic velum the levators of the palate contribute largely."

Baker's Velum.—Dr. Henry Baker describes his appliance as follows: "Numerous experiments to provide an artificial appliance

FIG. 183.

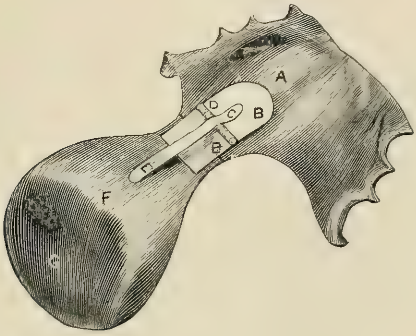


The cleft, extending a little beyond the soft into the hard palate.

with hard rubber, utilizing the levator muscles to control the movement of the appliance, and with which articulation could be learned as well as with the perishable soft-rubber velum, resulted in my adoption of the following device in cases where the cleft extends a little beyond the soft into the hard palate, as shown in Fig. 183. The appliance consists of a gold or hard-rubber plate (A, Fig. 184), covering the roof of the mouth down to the junction of the hard and soft palates. From this point the movable portion, F, extends back and downward, restoring symmetry of the palatal surface by

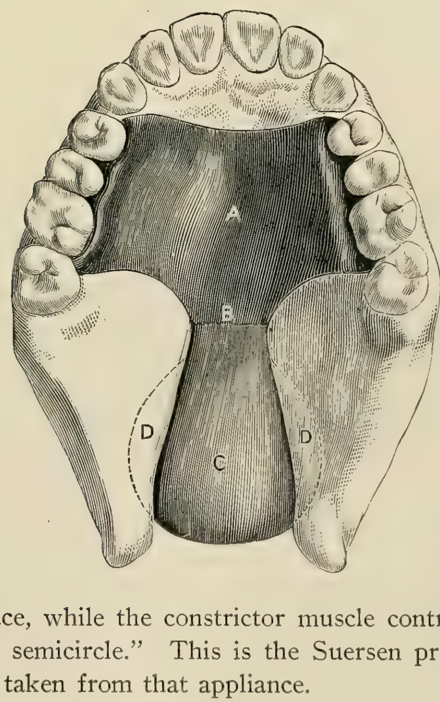
bridging across and lying upon the muscles of each side. C E is a spring controlling the upward movement of F. The distal sur-

FIG. 184.



face, G, or that portion coming in contact with the pharyngeal wall, is quite broad, and so constructed as to articulate perfectly

FIG. 185.

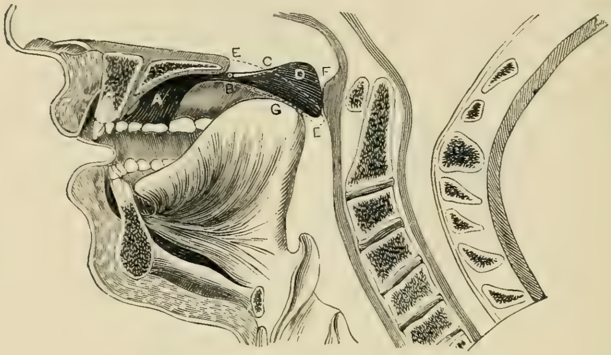


with this surface, while the constrictor muscle contracts and closes around it on a semicircle." This is the Suersen principle, and the main ideas are taken from that appliance.

The velum is of polished hard rubber, gold, or platinum, and much resembles a chestnut in form.

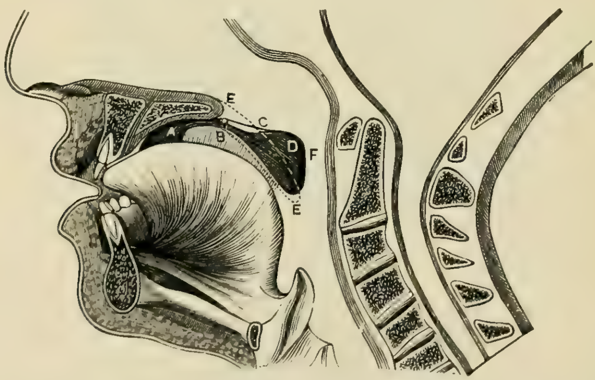
It is attached to the plate with a hinge-joint, B B, thus giving

Fig. 186.



free movement at the junction of the hard and soft palates. At the junction of the hard and soft palates there is a stop, which prevents any downward pressure upon the muscles when in a relaxed condition.

Fig. 187.



The muscles relaxed, the appliance descended, thus giving a free passage for nasal sounds and respiration.

Fig. 185 shows the appliance in position, the dotted lines showing the part of the appliance resting on the muscles.

The main advantages of this appliance are that it is made of a durable material, is easily constructed, and that articulation can be

learned with it more readily than with any other appliance. In addition, it is so easily movable as to be acted upon by, and be under perfect control of the muscles by which it is surrounded. In studying the mechanism of speech, we learn that more than three-fourths of the sounds of articulate language depend upon the integrity of the soft palate for their perfect enunciation. This being the fact, articulation with a rigid obturator must be extremely difficult to acquire. If three-fourths of the sounds depend on the free movement of the natural palate, it seems a sufficient reason why provision should be made for the same movement in an artificial one.

Dr. Kingsley says that with a yielding appliance the levators of the palate contribute largely to correct speech. The surrounding muscles have control over the appliance here described in the following way: The artificial velum bridges across the opening and lies upon the muscles of either side. (See Fig. 185, D D.) With all sounds requiring the closure of the nasal passage it is thrown up by the levator muscles, as shown at D in the sectional Fig. 186, there being no resistance. The thickness of the velum brings its posterior surface in close apposition with the superior constrictor muscle, F, affording in the pronunciation of the gutturals a firmer resistance to the pressure of the tongue, G, than can be obtained with a thin obturator. By the presence of the hinge, B, the above movements are rendered so free and facile that there is no tendency to displacement of the plate, such as occurs with a rigid appliance. If a nasal sound immediately follows a guttural, the descent of the velum is rendered certain by its own weight, even if not aided by the spring.

CHAPTER XXVIII.

APPLIANCES FOR THE CORRECTION OF FRACTURED MAXILLÆ.

(Interdental Splints.)

Dentists are peculiarly fitted to overcome the mechanical difficulties in the treatment of fractures of the maxillæ; while the general surgeon, whose services are usually first sought, encounters many annoyances, and seldom secures a correct adaptation and retention of the fragments in their normal position. In fact, all of the approved appliances and methods have emanated from dentists.

Fractures of the jaw are unmistakable, the prominent symptoms being pain, swelling, drooling, mobility of the fragments, crepitus, and displacement of the teeth. If there is any doubt as to the location of the fracture of the lower jaw, the operator should be seated in front of the patient, and gently but firmly grasp the bone on either side, allowing the forefinger to extend into the mouth and rest upon the teeth, when the false point of motion or crepitus will be readily recognized.

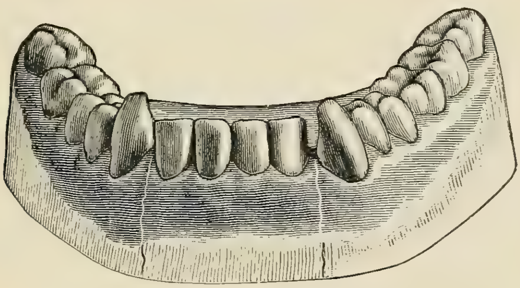
The Division of Fractures.—Fractures are divided into simple, compound, and comminuted. *Simple,* when the bone only is broken without piercing the integuments; *compound,* when the fracture is accompanied by laceration of the tissues through to the surface, so as to establish communication with the air; *comminuted,* when the bone is broken or crushed into several pieces. If the body of the bone is involved, fractures of the lower jaw are usually compound in the direction of the mouth; but when the ramus, condyle, or coronoid process are fractured this is not the case (on account of their being so deeply seated) unless the wound is caused by a gunshot or missile. Several cases of fractured maxillæ have been sent to the writer for treatment, at the clinics of the Pennsylvania College of Dental Surgery. These operations have been carried out according to the principles herein described, and with entirely satisfactory results.

Securing the Impression.—The fundamental principles of taking the impressions of both jaws and reconstructing the model of the fractured jaw by articulating the teeth to the cast of the unbroken jaw, and upon this making the appliance, or splint, were inculcated by Drs. Gunning and Bean.

The impression of both jaws should be taken, either in wax or modeling compound, using as small a quantity as will insure a good impression of the teeth and gums. That of the uninjured jaw should be taken first, thus gaining the confidence of the patient, and deferring the most painful operation until the last.

As it is impossible to keep the fragments of a fractured inferior jaw in perfect apposition while taking an impression, *no attempt should be made to entirely reduce the fracture at this time.* The sec-

FIG. 188.



tions, however, should be brought as nearly to position as possible without causing much pain to the patient.

An assistant should stand behind the patient and support the broken jaw, keeping it steady while the impression is being taken. This is more important, however, when the fracture is double.

The impression material being ready, it should be introduced into the mouth and carefully brought to position, and much care should be exercised to prevent the pieces of bone and loosened teeth from moving when this material is being molded about their necks.

Preparing the Models.—After the impression has been secured, mix plaster and pour cast in the usual manner. Figs. 188 and 189 represent casts showing double fractures.

The casts or models of both jaws being obtained, they should be carefully articulated. This is done by cutting, with a small saw,

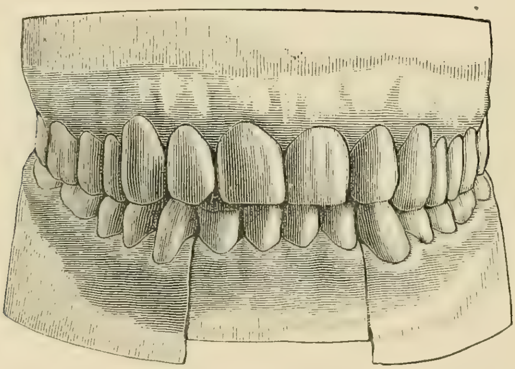
the lower cast at the point, or points, of fracture, and rearranging the sections thus made so as to bring the teeth of the two models into correct articulation. This is represented in Fig. 189.

The pieces should then be secured in this position with plaster and the two models placed in an articulator.

Forming the Splint in Wax.—Any interdental dovetail spaces should be filled with soft plaster, so that the splint when finished can be readily adjusted and removed.

The articulator should now be arranged (by the set screw in the back) so as to open the bite about ½ of an inch. Carefully cover teeth and gums of both casts with No. 60 tin-foil. Over this covering of tin-foil build up the splint in wax. This is best done

FIG. 189.

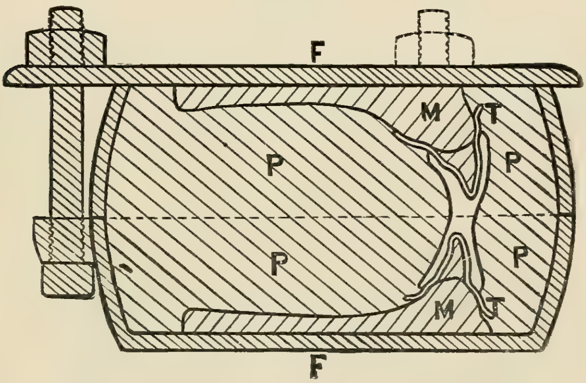


as directed by the late Dr. Alonzo Beal.* First, place two layers of thin base-plate wax over the teeth of both models, allowing it to extend just beyond the necks of the teeth upon the gums, but not quite to the edge of the tin-foil. Then make a strip of wax about $\frac{3}{16}$ of an inch thick and wide enough to fit between the pieces of wax on the models, and long enough to extend as far back as they do, joining the three pieces together with melted wax. Pass a hot spatula all around the edge of the wax, where it joins the tin-foil, to make a perfect joint. The object of the tin-foil is to make the rubber smooth, and to have the splint, when finished, a trifle larger than the natural teeth, so that it will pass into position without binding at any point.

* "American System of Dentistry," Vol. ii.

Flasking.—The wax splint and tin-foil covering, now being one piece, should be removed from the models and the models carefully taken from the articulator. Trimming their bases and sides is necessary, so that when the splint is in position on them the whole will fit in the vulcanizing flask. The lower model, with the splint upon it, should be flasked first and the investment allowed to extend half way up the splint. Trim, varnish, and oil. Place the upper model in position in the splint and finish flasking. By allowing the tin-foil to extend beyond the wax (as at T, Fig. 190) the investment holds it in position when the wax is removed. Fig. 190 gives a sectional view of the flask with the splint invested. F represents the flask; M, the models; P, plaster investment; T, tin-

FIG. 190.

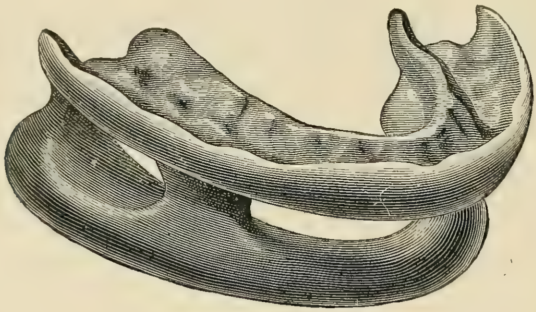


foil coverings of the teeth extending beyond the wax splint; W, wax model of splint. Before opening the flask place it in hot water to soften the wax. Separate the sections carefully. Wash the wax out by pouring boiling water upon it, instruments not being used, as they are liable to injure the tin-foil.

Packing and Vulcanizing.—Liberal outlets for the rubber should be made in both sections. Cut the rubber into thin strips and soften over boiling water. It is also advisable to cut up a piece of previously vulcanized rubber, small pieces of which may be packed in between the other rubber at the thickest points, making it less liable to become porous in vulcanizing. Pack each section carefully and thoroughly a little more than full. Place the sections together, boil, and close them in the usual way. In vulcanizing,

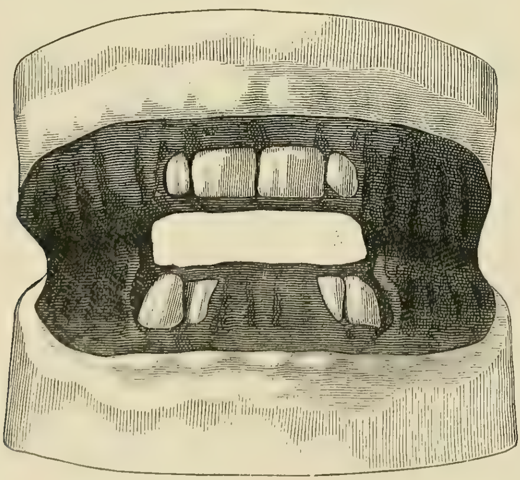
allow the mercury one hour to rise to 320° F. When this point is reached the temperature should be kept uniform for one hour or more.

Fig. 191.



Finishing.—When the flask is taken from the vulcanizer and has become cold, carefully remove the plaster and tin-foil from the rubber. In trimming, the rubber should be cut away nearly to the necks of the teeth and the edges all nicely rounded. The opening

Fig. 192.



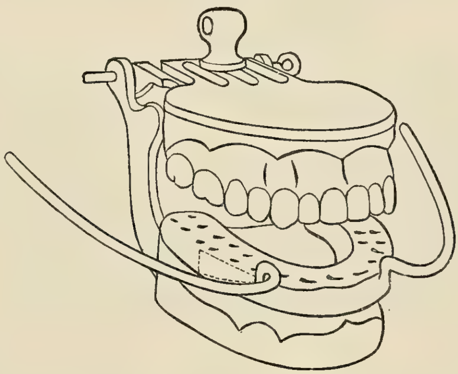
made in the splint for feeding purposes should be in front, if possible, and large enough to allow for the free passage of a feeding tube, and should have the edges well rounded. The splint should now be immersed in dilute muriatic acid to dissolve the tin, after

which it should be carefully finished and polished. Fig. 191 represents the completed splint. It is often advisable to make openings through the top or side of the splint against each tooth adjoining the fracture, so that it can be determined when the fractures are in place. This plan is represented in Fig. 192.

Securing Splint in the Mouth.—The splint is now ready to be adjusted in the mouth, and if the foregoing instructions have been closely followed the teeth of the superior jaw will readily slip into place. After so placing it, carefully manipulate the lower jaw, *reducing the fracture and bringing the teeth to position in the splint.* The jaw should then be firmly secured by external bandages.

The Kingsley Splint.—A splint devised by Dr. Norman W.

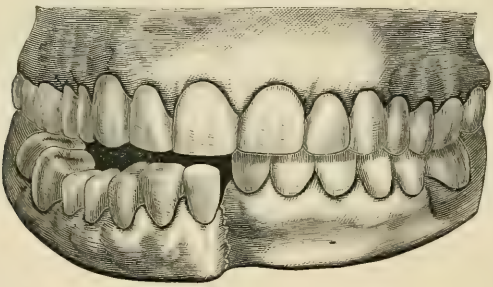
FIG. 193.



Kingsley consists of a vulcanite covering to the lower teeth, having two steel wires attached extending out of the corners of the mouth and then backward along the cheek on a line with the teeth. It is held in position by having the wires bound to a sub-metal splint of padded wood. The upper teeth must articulate with the upper surface of the rubber, so that the patient can use it for mastication. Take upper and lower impressions; pour models and articulate them, as before described, and place them in an articulator. Upon the lower model carefully press a piece of wax about one line in thickness over the teeth, allowing it to encroach a little upon the gums. Close the articulator to make the imprints of the upper teeth in the wax. The best method to make the arms is to use a couple of old dental excavators. Flatten the ends which are to be

imbedded and curve them carefully, so that they will pass out of the mouth and extend backward without pressing hard on the corners of the mouth, and terminate near the angle of the jaw. The flattened ends should be made quite broad and be thoroughly imbedded

FIG. 194.



in the splint, as much strain comes upon them. Fig. 193 represents this form of splint.

The following cases, taken from the practice of Dr. Kasson C. Gibson, of New York, are of especial interest in this connection. Fig. 194 represents a fracture at the symphysis; Figs. 195 and 196 the displaced fragments sawed from the casts.

FIG. 195.

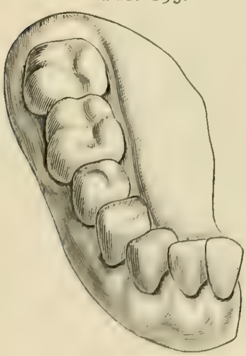
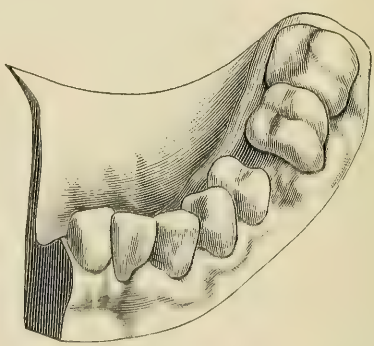


FIG. 196.



The occluding or grinding surfaces of antagonistic teeth are unmistakable, and there is no excuse for making an error in resetting the plaster model. Should any discrepancy occur, it will be fatal to the success of the appliance. In all cases where there are

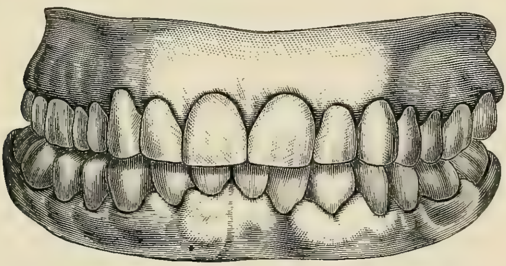
teeth which occluded with those of the opposite jaw (previous to the fracture) a mistake is impossible, if care be exercised.

Fig. 197 shows the plaster fragments placed in their normal position and cemented together, ready for the articulator.

If fractures where the teeth are missing, take an impression of the alveolar ridge in the same manner as for artificial teeth, and there will be no difficulty in correcting the model. The splint should be molded with wax on the reconstructed plaster cast, and must embrace each fragment of the jaw. If to be used for mastication, the splint should cover all the teeth.

After modeling the splint in wax, and just before removing the cast for flasking, soften the wax with dry heat. (The grinding surface of the teeth should have been previously oiled to prevent their adhering.) Then close the articulator, forcing the grinding

FIG. 197.



surface of the upper teeth into the wax, thus giving a uniform grinding surface. Before packing the rubber, cover the teeth and model with two or three thicknesses of tin-foil. There are two reasons for doing this: first, it makes the splint a trifle larger; second, it gives a clean surface. After vulcanizing, immerse the splint in diluted muriatic acid to dissolve the tin. Interdental splints ought to be so adjusted that mastication can be performed.

In many fractures of the lower jaw it will be impossible to hold the fragments in the splint, in their normal relations, by merely attaching them to the splint. In these cases the appliance must be supplemented by an external metal compress, so attached to it that the jaw will be held as in a vise. The tightening of this compress forces the fragments into the splint and securely holds them.

Fractures of the upper jaw require but little treatment compared

with those of the lower, since the bones are naturally immovable, and there is little difficulty in keeping the fragments in position.

The length of time necessary for wearing an interdental splint is variable; the shortest time, however, being about three weeks.

Brief histories of the following cases are furnished as illustrating the different methods and appliances used in the treatment.

Case 1.—Male, aged fifty. Treated at Bellevue Hospital. Lower jaw fractured on the left side, the line extending through the body between the cuspid and first bicuspid. The displacement of the posterior fragment was downward and outward. No displacement of the right side.

The splint used for this patient was made of vulcanite, covering all the teeth, and held in position by first tying ligatures to the teeth and afterward to the splint. The holes on the grinding surface were for two purposes: first, to ascertain if the teeth were in proper position; second, to introduce the nozzle of the syringe for cleansing. After reducing the fracture and adjusting the splint, the patient was enabled to masticate without any difficulty. The splint was worn about four weeks, and on its removal occlusion of the teeth was found to be correct.

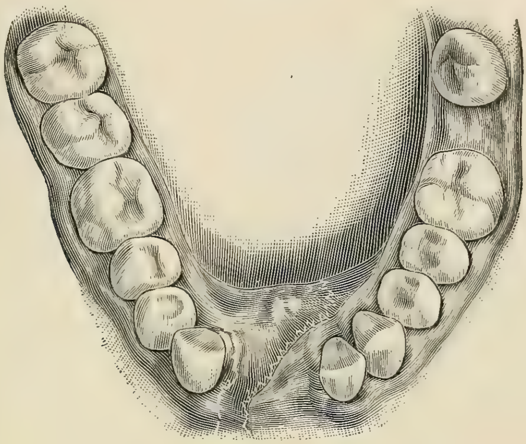
Case 2.—Male, aged thirty-five. Treated in Bellevue Hospital. Lower jaw fractured in two places; on the right side between the lateral incisor and cuspid, and on the left of the symphysis, between the central and lateral incisors. Two incisors on the right side and one on the left side had been knocked out at the time of the injury. The anterior fragment was forced back and downward under the tongue; the left side of jaw displaced downward and inward. (See Fig. 198.)

A splint similar to the one just described was applied, except that after inserting the splint and reducing the fracture a chin piece of gutta-percha (the impression material now used by dentists is much better), padded with cotton, held in position with a four-tailed bandage, was added. Nourishment was taken through a space left in the splint. (See Fig. 199.)

After a few days it became necessary to remove the chin piece, as the patient complained of soreness and pain. It was then discovered that an abscess had formed on the left side of the symphysis. This, on being opened and probed, was found to contain a small piece of bone, which was removed. The parts were cleansed

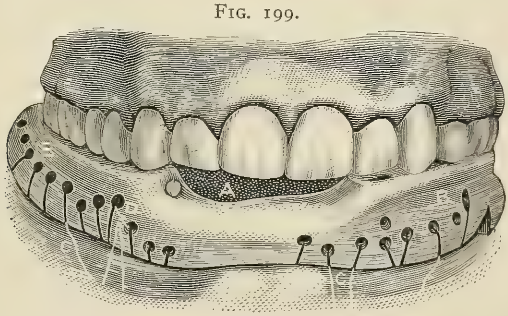
with a solution of carbolic acid and glycerin, the cotton padding renewed, and the chin piece reapplied. This was frequently removed for renewing the cotton and for treatment of the abscess,

Fig. 198.



which healed in a few days. About this time a second abscess formed under the splint, near the symphysis. This, on being opened, contained a piece of alveolar process, which was removed.

Fig. 199.



A. Space through which nourishment was taken. B, B. Holes and slots for tying the ligatures to the splint, these having been previously tied around the teeth. These holes were also used for introducing the nozzle of a syringe for cleansing. C, C. Ligatures. D. Ligature tied.

Later several other pieces of alveolar process presented themselves at or near this opening, and were removed. At the end of three weeks the union of the fragments was sufficiently firm to permit

of the removal of the chin piece, allowing the use of the jaw for mastication. The bandage, however, was retained, except when nourishment was being taken. The splint was removed after being worn about six weeks, when occlusion of the teeth was found to be correct.

Case 3.—The patient, a miner, aged twenty-seven. Three days before admission to the hospital, May 2, 1872, he was injured by a splinter of wood from an explosion of nitroglycerin. Examination revealed a compound comminuted fracture of right half of inferior maxilla. There were three points of fracture: first, between the left lateral incisor and the cuspid; second, between the bicuspids; third, at or near the angle of the jaw; considerable displacement of all the fragments.

The anterior fragment, containing three incisors, the cuspid, and first bicuspid, was depressed ½ of an inch and displaced backward. The middle fragment, including the second bicuspid and three molars, was carried up nearly to the median line and slightly backward. The posterior fragment was slightly elevated.

A splinter of wood about ½ of an inch long had been extracted from an external wound which extended inward from the symphysis for 1½ inches along the line of the jaw. A clot of blood occupied the left side of the floor of the mouth; there was also considerable swelling about the face. The patient swallowed with difficulty, fluids escaping through the nose; articulation very indistinct.

May 3. Patient partook of milk through a glass tube with less discomfort than the day before.

May 4. Patient still unable to swallow with ease, although the swelling had greatly subsided. An attempt was made to introduce the stomach-pump, but patient would not submit. In the afternoon Prof. Stephen Smith saw him and advised wiring the anterior fragments in order to draw and retain the tongue forward. This was accomplished, though not without some difficulty, and the patient drank two glasses of milk. About two hours later the wire broke, but the patient was able to swallow as well as before, although complaining of pain during the act.

May 5. Patient took three cups of coffee. Fragments again wired in position.

May 6. Patient swallowed all the food he wished. Wire failed to hold fragments in place.

May 7. Swelling had almost disappeared. Odor from the mouth was very offensive.

May 9. Large fragment of the jaw, containing one bicuspid and two molars, became detached during the night, and the third molar also came away (Fig. 200). Treatment up to this time consisted of

FIG. 200.

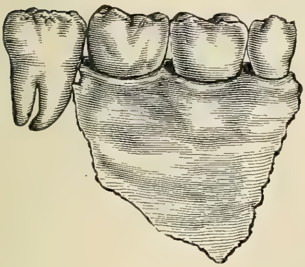
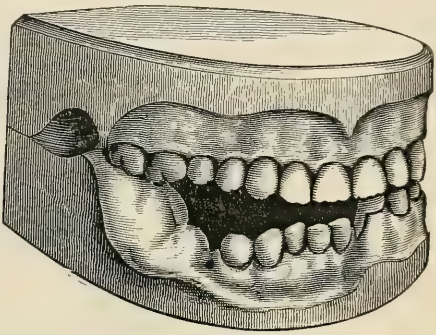


FIG. 201.

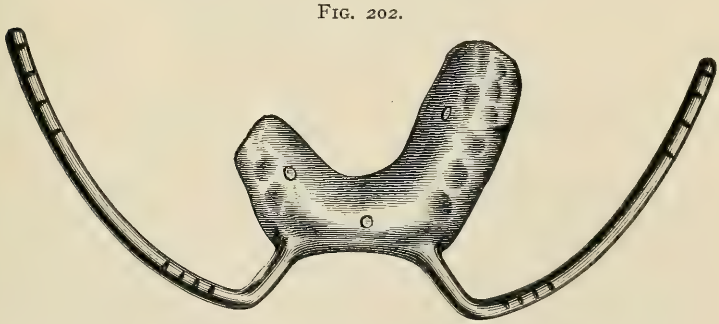


Model showing displacement.

disinfecting the mouth with a solution of carbolic acid and glycerin. The wound was also dressed with the same, and the jaw supported with a four-tailed bandage.

May 15. Impressions were taken in plaster-of-Paris preparatory to making an interdental splint (Fig. 201). This was constructed

FIG. 202.



similar to those already described, with the addition of two steel wires (old excavators) vulcanized in the splint and curved upward as they emerged from the corners of the mouth, thus avoiding pressure on the lip, and extending backward nearly to the angle of the jaw (Fig. 202). A rubber band was substituted for the bandage,

and extended from one steel wire under the jaw to the other, outside of the gutta-percha chin piece.

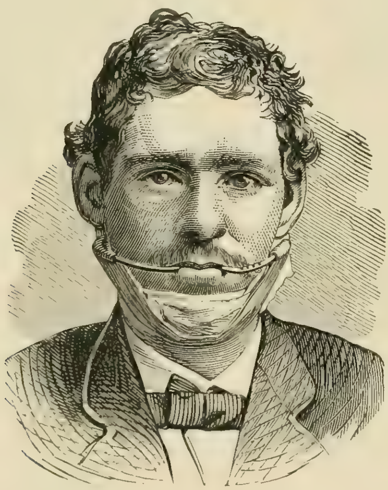
May 19. Interdental splint adjusted (Fig. 203). Patient removed this five hours later, on account of considerable pain on the right side of the symphysis.

May 20. A very tender induration appeared posterior to and below the cuspid and first bicuspid of the right side. On opening this, a small piece of bone was found and removed.

May 21. Splint readjusted. Patient ate and slept well.

May 23. Splint again removed by patient, as he could not endure

Fig. 203.



the pressure. Bandage applied, which imperfectly held the fragments.

May 28. Interdental splint readjusted and fragments placed in position. Wound under the chin nearly healed.

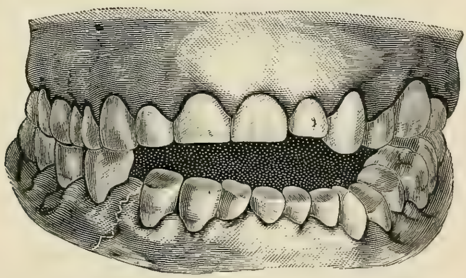
During a period of ten days after the readjustment of the appliance, it was found necessary occasionally to remove the chin piece for some hours, owing to extreme pain and tenderness of the external surface. Cotton and a bandage were temporarily substituted for the chin piece and rubber band. Both pain and tenderness were partly caused by the pressure requisite to retain the fragments and splint in position. The splint was constantly worn, except at such times as were necessary to remove it for cleansing. After two

months, firm union was found to have taken place, and occlusion of the teeth correct. This case appears in an article written by Dr. N. W. Kingsley, published in *Johnston's Miscellany,* in January, 1874, wherein Dr. Kingsley gives Dr. Gibson (who was at that time his assistant) credit for making and adjusting the splint.

Case 4.—Male, aged about sixty. Lower jaw fractured on the right side, between the bicuspids. Previous to admission to hospital he had been treated with gutta-percha covering the teeth, and a four-tailed bandage. About four weeks after the accident these were removed, as union had taken place, but upon examination all the teeth to the left of the fracture, back to the wisdom tooth, were found to be displaced downward from ½ to ¼ of an inch (Fig. 204).

Impressions were taken, and a splint made similar to that described in Case 3. *The patient was etherized and the jaw refractured*

FIG. 204.



at the same point. The splint was adjusted and held in position as in Case 3. About twenty-four hours after the adjustment of the appliance, the patient complained of numbness extending from the point of fracture to the symphysis. On examination, after the removal of the chin piece, it was thought that this was due to an injury of the nerve at or near the mental foramen. It remained for some weeks, but eventually normal sensation was regained.

The splint was worn with comfort for six weeks, the chin piece being occasionally removed for the purpose of cleansing. Occlusion of teeth was found correct at this time.

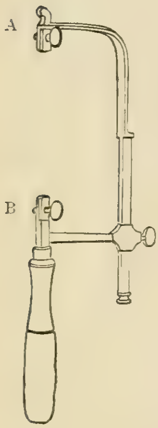
Case 5.—Male, aged thirty. Lower jaw fractured at the symphysis. The left central incisor, being loose, was removed. The right fragment was displaced downward and inward; the left inward.

The splint used in this case was similar to the one last described,

except that for the steel wire, gutta-percha chin piece, and rubber band, an external metal compress was substituted. This was constructed from a saw-frame such as is used by mechanical dentists (Fig. 205). To this was attached a revolving brass chin piece (Figs. 206 and 207); this was padded with spongiopilin covered with oiled silk (Fig. 208). The splint was worn four weeks, when occlusion of the teeth was found to be correct.

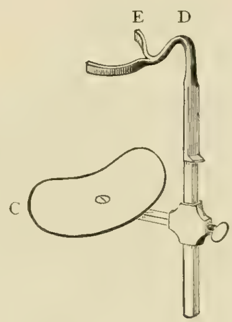
This external metal compress was found to be simpler in its construction, more readily applied, and more effective. The chin piece

FIG. 205.



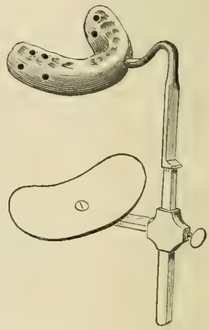
The handle and the parts marked A, B, were removed.

FIG. 206.



C, revolving brass chin piece. The rod at D, the point of contact with the lips, is made round to avoid irritation, and at E is split and bent to nearly conform to the contour of the jaw and teeth. To this (E) is attached the vulcanite.

FIG. 207.



Vulcanite attached. The top holes serve for ascertaining if splint and fragment are in position; the side holes are for cleansing.

should be made of any size or form the case may require. If there are external wounds or abscesses, holes should be cut in the chin piece corresponding with these, thus permitting drainage and treatment.

For the reduction or retention of any fracture of the lower jaw, with much displacement, and where external pressure is required, this form of splint will prove as effective as any appliance that may be employed. When used, it is not always necessary completely to reduce the fracture at the time of introduction. The use of the jaw

for masticating will gradually cause a proper adjustment of the teeth to the splint.

Case 6.—Male, aged about forty. Lower jaw fractured at the symphysis. Left side displaced downward about ¼ of an inch and carried inward. Appliance similar to that last described. Fracture reduced without any difficulty. After wearing the splint four weeks, occlusion of the teeth was found to be normal.

Case 7.—Male, fifty-two years of age; while assisting in launch-

FIG. 208.

Appliance in position (from photograph of patient).

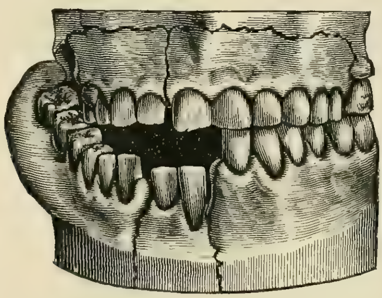
ing a ship, was struck by a heavy bar across the left side of the face. Admitted as a patient to Bellevue Hospital.

Examination revealed a lacerated wound an inch long, situated ¾ of an inch above the right angle of the mouth. The lower jaw was fractured in three places: First, at the end of the symphysis, between the central and lateral incisors; second, at the right of the symphysis, between the central and lateral incisors; third, at the angle back of the last molars, right side. The anterior

fragment was displaced downward and backward, and the large fragment on the right, containing six teeth, was depressed at the anterior end, much elevated at the posterior. No displacement of the left side of the jaw.

The wound in the lip was closed with silk sutures, and a four-tailed bandage applied to the jaw, but a few days' trial proved its inefficiency. Impressions were then taken for an interdental splint. Upon removing impression of the upper jaw, this also was found to be fractured as follows: first, from behind the second bicuspid on the right side across the roof of the mouth, through the alveolar process on the left side, where the first molar had been extracted, then around in front, above the teeth, to the right side; second, between the central and lateral incisors of the right side,

FIG. 209.



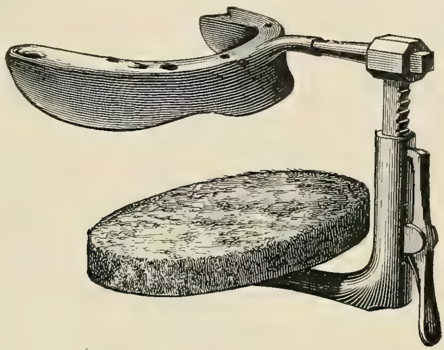
running along the median line and intersecting the fracture before described (Fig. 209). The two fragments containing all the teeth anterior to the molars were slightly displaced. These fractures were readily readjusted and held with ligatures.

For the lower jaw the splint similar to that used for Case 5 was applied March 9th, with the exception that the tongue-holder or duct compressor (used by dentists) was substituted for the saw-frame; the chin piece padded with spongiopilin covered with oiled silk. From that date the patient experienced no discomfort, and ate the ordinary hospital food without difficulty (Figs. 210 and 211). On March 20th he was discharged from the hospital, and on April 10th the splint was removed. No deformity remained.

This case appears in Dr. N. W. Kingsley's article published in *Johnston's Miscellany,* February, 1874; also in his work on "Oral

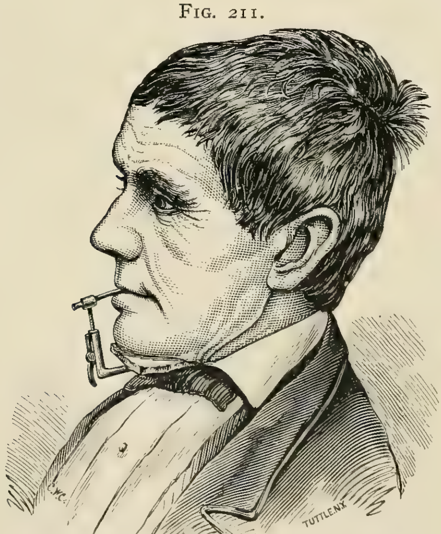
Deformities." From the former we quote: "The impressions, cast, and adaptation of this instrument were made by my assistants, Messrs. Gibson and W. H. Kingsley."

FIG. 210.



Case 8.—Patient, a policeman, aged thirty-five. Lower jaw fractured on right side, between second bicuspid and second

FIG. 211.



Appliance in position (from photograph of patient).

molar; the first molar having been extracted, third molar missing. An attempt had been made to reduce and hold the fracture by cov-

ering the teeth with gutta-percha and supporting the jaw with a four-tailed bandage.

Twenty days after the injury was received, on taking impressions for an interdental splint, it was discovered that there was no actual displacement of the anterior fragment, but the posterior one, including the second molar, was elevated about ¾ of an inch, the tooth coming in contact with the third molar on the upper jaw. The treatment was similar to that used in Case 7, and the fracture was reduced without any difficulty. The splint was worn with comfort for thirty days. On removal, the teeth occluded correctly.

Case 9.—Male, aged about twenty-five, subject to epileptic convulsions. Fracture due to a fall during one of these attacks. The lower jaw was fractured at the symphysis; right side displaced downward about ¼ of an inch; anterior end of fragment outward; posterior portion of jaw inward about ¼ of an inch. No displacement of left side of the jaw. An attempt had been made to reduce and hold the fragments in position with gutta-percha covering the teeth, and a four-tailed bandage.

Two weeks after the accident impressions were taken for an interdental splint, which was applied, the fracture being reduced without any difficulty. The splint was worn with comfort for five weeks, when it was removed, occlusion of the teeth being correct. A few minutes after the removal of the splint the patient had an epileptic seizure, although he had been free from these attacks during the treatment for fracture. Appliance similar to Case 8.

Case 10.—Patient, a boy, aged six. Two fractures of the lower jaw. First, between the lateral incisor and cuspid, left side; second, back of last temporary molar on right side. Displacement of anterior fragment downward and inward, each about ¼ of an inch; slight displacement of posterior fragment; no displacement of left side (Fig. 212). The splint used was similar to the one in Case 7, with necessary alterations (Fig. 213).

Attempts had been made to reduce and hold the fragments, first, with ligatures about the teeth; second, with gutta-percha covering the teeth and a bandage, neither of which proved effectual.

Three weeks after the accident an interdental splint was adjusted. Great difficulty was encountered in reducing this fracture. A few days later, the reduction not being satisfactory, the splint was removed, nitrous oxid administered, fracture reduced, and splint replaced.

The following form of appliance has been adopted as best meeting the requirements of cases needing an external metal compress. It consists of three parts: First, a compressor; second, a chin piece; third, an inner steel band or the wire splint, as shown in Fig. 214.

First, the compressor (used without alteration for all cases), con-

FIG. 212.

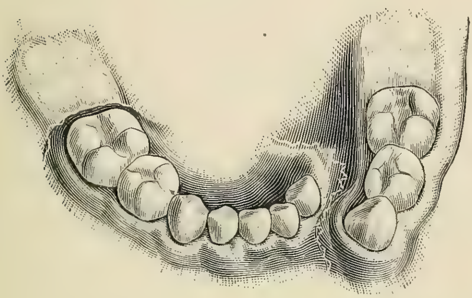
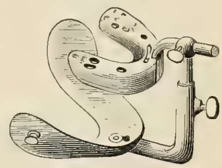
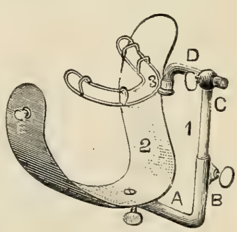


FIG. 213.



sisting of a horizontal rod (A) and a vertical rod (B), each about two inches in length, meeting at right angles. Rod B is hollow, and at its upper end is fitted a thumb-screw so adjusted as to hold at any point in it a movable rod (C), thus regulating pressure. Passing horizontally through a bulb at top of rod C is a rod (D) three inches in length, bent downward at right angles for about an inch. One-half of this lower end is smaller in diameter than the other half, leaving a shoulder. A thumb-screw in the bulb admits of the adjustment of rod D at any angle.

FIG. 214.



Second. The chin piece is attached to the compressor by a thumb-screw, so adjusted that it may be pushed backward and forward on the rod A, and at the same time affording a double rotary movement. The chin piece is made in different forms, each peculiarly adapted to the location of fracture. (*a*) If fracture is at or near the symphysis, the chin piece consists simply of a flat piece of brass placed directly under the chin; (*b*) if back of the cuspid teeth involving the molars, it should fit the chin extending back to the angle of the jaw; (*c*) if involving both the angle and the condyle, it must include the entire lower jaw, and extend to the line

of the ear. A metal button (E) should be attached on each side of the chin piece for use in attaching any necessary support. For support nothing surpasses a skull-cap, to each side of which can be attached a piece of elastic reaching to the chin piece; this in turn can be fastened to the metal button by a ring sewed in the end of the elastic.

Third. The inner steel bands are made of various sizes and shapes to conform as nearly as possible to the contour of the jaw and teeth, and are vulcanized in the splint.

This appliance has been so constructed that the external compress may be removed independent of the splint proper; temporarily where external wounds or abscesses need treatment; permanently where there is sufficient union to retain fragments.

Any irritation of the lips caused by the adjustment of the rod at the median line may be remedied by removing (the patient having previously closed the jaws firmly) the external compress and readjusting it at any point to the right or left.

Splintage for Section of Inferior Maxilla.—In certain operations designed to reach the zygomatic fossa and in external pharyngectomy an interdental splint has been employed with much satisfaction. A very interesting case in point* is that treated by George R. Fowler, M.D., Professor of Surgery in the New York Polyclinic, and Rodriguez Ottolengui, M.D.S., of New York. After some preliminary remarks upon different methods of procedure, or forms of operations, Dr. Fowler says that section of the maxilla, as heretofore accomplished, has consisted in dividing the bone either just above, or in front of the angle, *i. e.*, either through the ramus, in which case the saw-cut runs in a *horizontal* direction, or through the body of the bone, the section being made *vertically*. These sections were first proposed by Mikulicz, to which he added, in cases of external pharyngectomy, removal of a portion or the whole of the ascending process, or ramus of the jaw. The latter is usually an unnecessary mutilation and seriously interferes with the functions of the jaw, as well as leading to an unsightly appearance of the parts. If the section is made in front of the angle and in a vertical direction, the angle itself is in the way of complete access to the parts above the latter, an important consideration both in neurectomy at the foramen ovale, and in external pharyngectomy.

* Reported in the *Items of Interest*, January, 1897.

In order to overcome these objections, Dr. Fowler makes an *oblique* section directly across the angle itself. This is done with a chain saw, the attachments of the masseter upon the external, and those of the internal pterygoid upon the internal surface of the jaw, being first detached. The soft parts are raised, together with the periosteum, which is stripped from the outer and inner surface of the bone by means of the rugine or raspatory. The chain saw is passed beneath the periosteum, and the cut commenced just posterior to the site of the wisdom tooth. The jaw is steadied by an assistant, and the chain saw so directed that the cut shall terminate at the point of the angle. By this means an oblique section is made across the angle, and a result produced, when readjustment of the divided bony parts is effected, not unlike what is known among mechanics as a "miter." The advantages gained, in the way of access to the deeper parts, are beyond question, and are illustrated in Fig. 215.

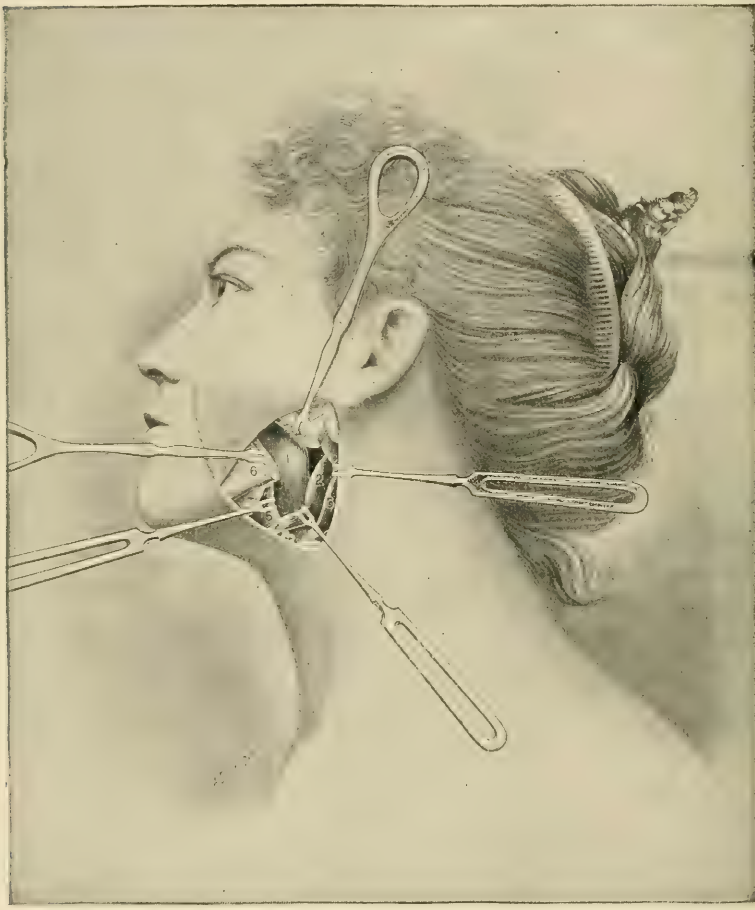
In the case of a young lady, operated on for the removal of a sarcoma of the tonsil and its neighborhood, it was determined to overcome, if possible, the disadvantages which constituted the objectionable features of the older methods of bone section, and readjustment of the fragments and the maintaining of the same in their proper relations. In furtherance of this desire, Dr. Fowler conceived the idea of having a proper interdental splint made preliminarily, which could be applied immediately after the completion of the operation, and which should automatically adjust the divided parts and maintain them in their proper relations, thus assuring a perfect restitution of their physiological functions.

Accordingly, a few days prior to the operation he called into requisition Dr. Ottolengui, whose ready appreciation of the necessities of the case proved to be invaluable in carrying the latter to a most successful termination, so far as the mechanical difficulties to be overcome were concerned. The necessary casts were obtained and an interdental splint constructed.

All being in readiness, the operation of external pharyngectomy, with oblique section of the jaw at the angle, was performed. Upon the completion of the operation, the bony parts were readjusted. It was found that the two halves of the obliquely divided ramus and body of the jaw fitted together like the united corners of a

picture frame, the comparatively long cut and the broad bony surfaces aiding this materially.

FIG. 215.



1. Hyoglossus muscle. 2. Retracted posterior belly of the digastric. 3. Stylohyoid muscle divided at its lower and anterior attachment at 4. 5. Mylohyoid muscle, retracted anteriorly. 6. Body of inferior maxilla.

But as it was subsequently discovered that the slight separation of the jaws which the interdental splint produced displaced the body of the bone in a forward and downward direction, and sepa-

rated the fragments, it at once became evident that a splint was needed which would admit of adjustment of the tooth surfaces to each other with the minimum amount of intervening space. This was undertaken and successfully accomplished by Dr. Ottolengui.

The patient was fed at first by a tube led through the external wound and into the pharynx. Through this tube, also, frequent irrigations of the parts with potassium permanganate, as well as the application of peroxid of hydrogen solution, were carried on. Subsequently the feeding and irrigation were effected by means of a soft rubber catheter passed between the metal splint and cheek, and into the pharynx.

The splint was dispensed with in the third week and movements of the jaw permitted. The healing was uneventful, and the masticatory function of the jaw, despite the fact that the callus thrown out in the reparative process was at the site of the attachments of the internal pterygoid and masseter muscles, was complete. A point worthy of note in the case is the fact that almost perfect restoration of phonation finally took place, despite the fact that in the operation for the removal of the diseased parts it became necessary to remove, in addition to the tonsil and underlying parts, all of the faucial pillar and at least three-fourths of the velum. The cicatricial contraction which followed the healing process upon the diseased side, displaced toward the median line the remains of the velum. The effect of this, as well as the control over the movements which the patient obtained, was finally sufficient to produce occlusion of the postnasal space, and overcome to a great extent the nasal sound of the voice which at first was quite marked.

After constructing and inserting a modified form of the Gunning splint, which seemed to fit accurately and comfortably, the divided jaw was held in position by a series of bandages which covered the head, as well as the dressings over the wound in the neck, and passing around and under the chin. This, however, as has been stated, proved ineffectual, and Dr. Ottolengui describes the peculiarities of the case from this stage, as follows: "Two days later I was called to visit the patient, as she was suffering considerably from the splint. With some chagrin I visited the hospital, and upon examination discovered that in the region of the wound all the soft parts had become so much swollen that the splint, which at first did not touch the gum tissue at any point, was

now in contact with it, and had already caused a most painful abrasion. Had this been the only fault in the splint it would have been trivial in importance, easily remedied by cutting away all of that part of the splint which engaged the lower molars of that side, which I did, the splint being perfectly comfortable when replaced. Nevertheless I record this fact, as worthy to be remembered by all who may choose to make an interdental splint of rubber, especially when through neglect an operation shall have become necessary in order to bring the ends of the bones together, in order to introduce the splint. After all such surgical interference it is well to remember that swellings may occur immediately in the region of the fracture, and special caution should be taken to avoid impingement of the splint in this vicinity.

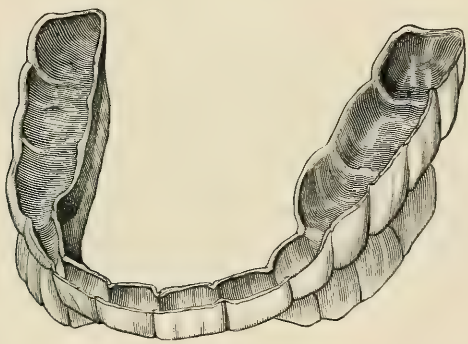
"But an examination of the parts, while I had the splint out, suddenly aroused a suspicion in my mind, which, if true, would prove that the splint was inherently wrong in principle. This visit being at night, I allowed the house surgeon to replace the splint and bandages, and arranged for a consultation with Dr. Fowler for the following morning, which fortunately was Sunday, so that I had the whole day at my disposal. At this examination we found to our regret that my suspicion was well founded, and that the splint would prove harmful; consequently a splint of an entirely new design was decided upon.

"*The fault in the splint lay in the opening of the jaws.* The main object of a splint, aside from obviating the necessity of wire suture, is to hold the jaws during the processes of union in such position that subsequently the occlusion will be correct. The double interdental splint was specially designed to this end, and has unquestionably accomplished the purpose in hundreds of cases, but these cases have been fractures of the bodies of the bones, the rami being unaffected. *I have little doubt now, that in cases where the ramus has been involved, perfect occlusion has not resulted, and moreover that it has remained unsuspected that the splint actually prevented such occlusion.* In the case of our patient, we found that the interposition of the splint caused a V-shaped gaping of the divided parts, and it was an unavoidable deduction from the premises that union would result from the deposition of new bone to fill this gap, so that after healing, while the jaws would accurately occlude with the interdental splint, *the splint being removed, the additional bone*

deposited in the ramus would preclude the possibility of perfect occlusion of the teeth, each set with the other."

Ottolengui's Splint.—"Under these circumstances I obtained new impressions of the jaws, and hurried from the hospital in Brooklyn to my office in New York, arriving in the laboratory at one o'clock. I started again for the hospital at five o'clock, carrying the completed splint with me. I mention this as an indication of what may be done in an emergency. Models, dies, and counter-dies are then made. Using 20-carat gold, 29 gage, I struck up a continuous cap to cover all of the teeth in each jaw, in the incisive region, however, extending only over the cutting edges. The plaster models, with the gold covering the teeth, were then occluded, and the two caps fastened together with hard wax. They were then invested and

FIG. 216.

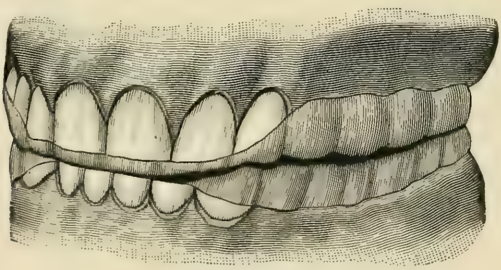


permanently united with solder. It may be useful to record a little trick in connection with the soldering, which saved a great deal of time. Of course the teeth of two jaws do not occlude like cog-wheels, consequently these gold caps were found to be in contact at some points, while spaces appeared at others. I took a piece of platinum wire and cut it into small bits, which I bent into suitable curves and dropped into the spaces. These bits of wire served as leaders for the solder, which flowed like water, closing the seam throughout its entire extent. Fig. 216 shows the form of this double interdental splint, made of gold.

"I mentioned that in the incisive region the splint extended only slightly over the cutting edges. There was a useful purpose in this, which is comprehensively shown in Fig. 217 where the splint

is seen as it appeared in the mouth. Had the labial surfaces of the anterior teeth been covered as well as the buccal surfaces of the posterior teeth, it would have been impossible to know positively that the jaws were properly in place within the splint; whereas by cutting away the gold from the faces of the anterior teeth, so that no gold whatever covered those surfaces, it could be determined readily, and at all times, whether the jaws were properly in position. In this respect the illustration is not perfect, as the artist has depicted the gold extending somewhat upon the labial surfaces, whereas in this region no gold whatever was visible, except that actually between the cutting edges of the teeth of the opposite jaws. This feature was shown to be of considerable value, as the tendency of the tired jaws will be to open, and these frequent efforts may stretch the bandages, thus allowing play to the mouth, which,

Fig. 217.



however, is readily detected by the attendant, who may ask the patient occasionally to endeavor to open the mouth, whereupon it can be observed whether the teeth move from their places in the splint, in which case the bandages can be tightened.

"This splint, when placed in position, caused absolutely no discomfort to the patient, was clean, free from odor at all times and proved to be all that could be desired. The long advocated feeding space was not missed, because at first the patient was fed through the tube which entered the mouth through the wound, and subsequently through a catheter which passed back between the cheek and jaws, entering the mouth behind the molars, the patient finding no difficulty to draw it in with the tongue, and to obtain liquids by suction."

So far as the records show this was the first use of a double

interdental splint, bringing the jaws into close occlusion, and abandoning the theory of the feeding space. As a division of the jaw at the ramus offers more difficulties than a fracture in the body of the bone, and as this form of splint is here shown to be adequate in such cases, there can be no necessity hereafter for opening the jaws and thus stretching and tiring the muscles, which by the method here advocated are all at rest.

Angle's Method of Fixation.—A comparatively recent and excellent method for treatment of fractures of the maxillæ is that devised by Dr. E. H. Angle, of Minneapolis, and through the doctor's courtesy I am enabled to give a full description of his methods and appliances here. He says: "The methods used by myself in treating fractures of the maxillæ have been so successful and so gratifying that it would seem they approach for efficiency and simplicity more nearly the ideal than any yet devised."

In order that this system of treating fractures of the maxillary bones may be more easily understood, we will divide them into three classes. The first class comprises all simple fractures in which the teeth are good and sufficiently firm in their attachments (especially on each side of the fracture) to afford anchorage for the appliance.

The second class comprises all fractures where the teeth are unsuited, from disease or any other cause, for anchorage, but yet sufficient to give the correct articulation of the jaws.

The third class comprises all fractures where the jaws are edentulous. The following cases, treated by Dr. Angle, will enable the reader to comprehend the method peculiar to each class:

Case No. 1 will illustrate class No. 1. A young man fell from a pile of lumber, a distance of 15 or 20 feet, and, besides severe bruises, suffered a simple fracture through the symphysis, terminating, however, in front between the central and lateral on the left side, as shown by the line in the engraving (Fig. 218).

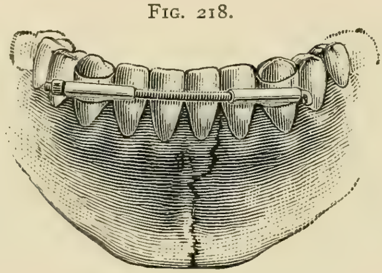
Upon examination, it was found that the fractured bone was quite widely separated at the top, and the left central incisor was loosened. The treatment practised was as follows: The ends of the fractured bones were placed in their proper position and temporarily fastened by lacing the teeth with silk ligatures. Bands of very thin German silver were made to encircle and accurately fit the cuspid teeth. A small tube of German silver, ½ of an inch in length, was soldered

to each band and in exact alignment; a piece of wire accurately fitting the bore of these tubes, bent at right angles at one end and having a screw cut upon the other end, was slipped through each tube and secured therein by adjusting a nut on the screw. The bands were cemented in position upon the teeth by means of oxyphosphate cement, as shown in Fig. 218.

After the cement had become thoroughly set, the nut was then tightened until the fractured ends of the bone were drawn snugly together.

The appliance was worn without displacement or trouble for twenty-one days, when it was removed, the bone having become firmly united. I may add, that during the time the appliance was worn, so firmly was the jaw supported, the patient suffered little if any inconvenience, and after the third day partook regularly of his

FIG. 218.



meals, using his jaws freely, but, of course, avoided the hardest particles of food. After removing the appliance a careful impression of the jaw was taken, a model made, and the appliance transferred to the model, exactly as shown in the engraving. The lower part of the jaw is, of course, diagrammatic, and was added by the engraver to show the line of fracture.

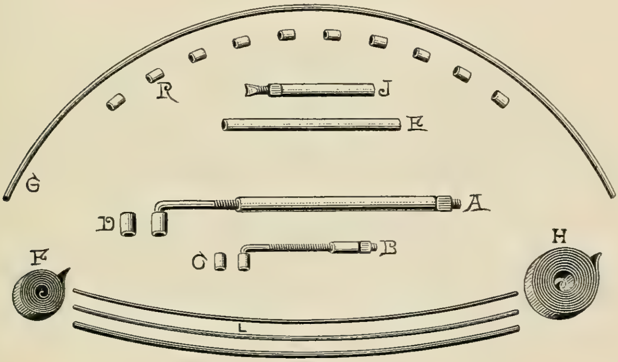
It should be borne in mind that the principle upon which this appliance is based is not the same as where the teeth are simply wired together, but very different; for in wiring, the upper parts of the fracture only are tipped or drawn together, and no pressure or support is given to the lower parts, while in the method here shown it will be seen that, by reason of the bands and pipes being rigidly attached to the anchor teeth, tipping is impossible, and pressure is exerted equally upon both parts (upper and lower) of the fracture as they are drawn together by the screw.

This device may be applied in any locality in either jaw, provided suitable teeth for anchorage be not too far remote from line of fracture. The screw may be bent to accommodate the curve of the arch, should the fracture occur in the region of the cuspid.

These bands, tubes, wires, screws, and nuts are some of the appliances known as "Angle's Regulating and Retaining Appliances," devised and used for the purpose of correcting irregularities of the teeth. They may be procured of dealers in dental goods. (See Fig. 219.)

The treatment for cases of the second class is illustrated in the following instance: On July 4, 1889, a man aged forty-five was admitted to the Minneapolis City Hospital. A blow from a police-

FIG. 219.



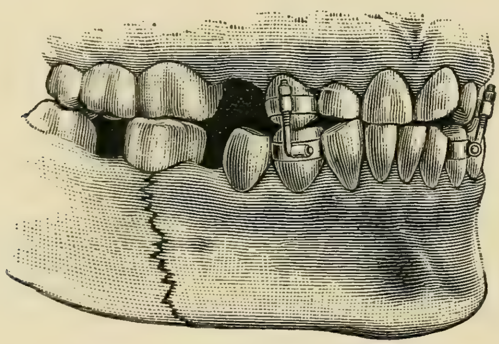
man's club had produced two simple fractures of the inferior maxilla. The first was an oblique fracture of the right side, beginning with the socket of the second bicuspid, extending downward and backward, involving the socket of the first molar, breaking out the second bicuspid, and greatly loosening the first molar. The second molar had been lost years before, while the third, as well as the remaining teeth, were much abraded and loosened by salivary calculus, thus making the application of the appliance described in Case No. 1 impossible. The second fracture was situated on the opposite side high up in the ramus.

Because of swollen condition of the parts, the exact line of fracture could not be detected, but the grinding of the ends of the bone and the great pain occasioned thereby were unmistakable evidences

of a fracture. The patient, as in all such cases, was unable to close the jaws. The fracture on the right side was widely separated, and the anterior piece much depressed by reason of the contraction of the depressor muscles, while the posterior bone was drawn firmly up, the molar teeth occluding. (See Fig. 220.)

The following is the treatment used: Bands were made to encircle all four of the cuspid teeth, they being the most firmly attached in their sockets. The fractured ends of the bones were placed in apposition, the lower jaw closed carefully. The occlusion of the lower teeth upon the upper required so much force and occasioned such intense pain that it became necessary to anesthetize the patient. Points on the bands for the necessary attachments were carefully noted. The bands were then slipped off the teeth, and

Fig. 220.



little pipes (shown at Fig. 219) soldered at the necessary points, after which the bands were cemented in their proper position upon the teeth, and two small traction screw-wires, the same as shown at Fig. 219, were slipped into the pipes. The jaws were closed and the nuts tightened on the screws, until the jaws were drawn firmly together, and each tooth occupied its exact position in occluding upon its fellow of the opposite jaw. Both fractures were then carefully examined and found to be in perfect apposition, and presented the appearance shown in Fig. 220. The most natural position for the jaw and the muscles had been secured, thus placing the parts in their natural positions of relaxation and rest.

During an attack of coughing during the night following, one of the bands was wrenched loose, but was replaced the next day with-

out trouble. No further accidents occurred. The patient readily took nourishment through the spaces between the teeth. Thus the fractured jaw was firmly supported without the least motion for twenty-two days, when the appliance was removed, showing most excellent results.

The following case possesses several points of special interest; the fractures were in regions similar to the case just described, and the appliances, though involving similar mechanical principles, will be found to be greatly simplified.

Thomas B. was admitted to the Dental Infirmary of the University of Minnesota, suffering from the effects of a blow received on the left side of the jaw from a cant-hook while working in a lumber camp in Wisconsin, which produced fracture of the jaw in two places. The first fracture was on the left side, beginning between the first and second bicuspids and extending downward and backward, and involving the lower part of the anterior root of the first molar. The second fracture was on the right side, directly through the angle of the jaw. The fractures had occurred thirty-two days previous to his admission to the infirmary, during which time nothing had been done to reduce them. He reported that he had called upon a physician, who supposed the trouble was merely an abscessed tooth, and had lanced the gum with the view of reducing the swelling. Later the patient had called upon a dentist in one of the smaller towns, who also failed to diagnosticate the fracture, and extracted both bicuspids, in the hope of giving relief. Upon examination I found considerable swelling in the region of this fracture, with the usual result; the patient being unable to close his mouth by reason of the anterior piece of the fractured bone being drawn down by the contraction of the depressor muscles. A false joint had also become established, and the bones could be easily worked without causing pain.

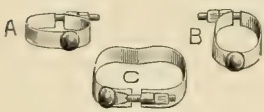
At the point of fracture on the right side there was little or no displacement; the swelling was also slight.

The patient was anesthetized. The ends of the bone were then rubbed forcibly together with the view of breaking up the false attachments and stimulating activity in repair.

The ends of the bones were now placed in perfect apposition, and the mouth closed, great care being taken to articulate the teeth in their correct position against the upper ones.

The jaw was now firmly bound in this position to the upper teeth, in the same manner as described in Case No. 2, with this difference, that the method was improved upon and simplified by using clasp bands, as shown in Fig. 221. No cement was used, and instead of the screws small metallic buttons were soldered to the sides of the bands (as shown in the cut), around which fine binding wire was wrapped in the form of a figure 8. (See Fig. 222.)

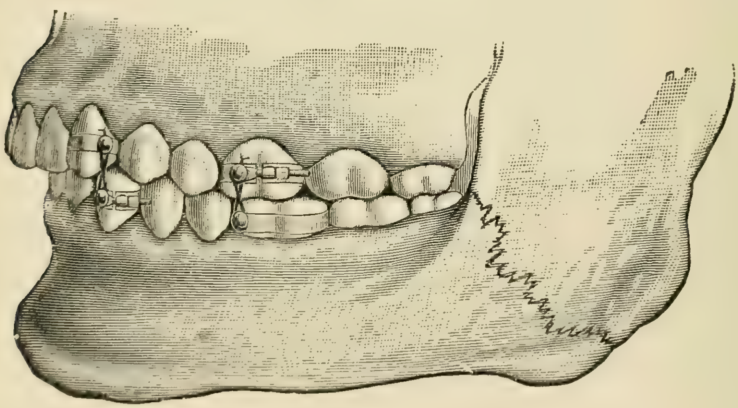
Fig. 221.



The bands seen upon the molar teeth in the engraving were not used in this case, but are shown for the purpose of illustrating how they may be used in case of comminuted fracture. At the end of seventeen days the bands were removed and the patient discharged, the bone having been firmly united.

Dr. Angle suggests that it might be urged as an argument against this method that, the teeth being closed and the jaws being firmly bound together, the patient would be unable to take sufficient

Fig. 222.



nourishment. It, however, rarely happens that a patient is found without some teeth missing, thereby leaving abundance of space for the passage of liquid foods, and even if all the teeth were sound and in perfect position, it has been proved that there is plenty of space between the teeth and behind the molars and between the upper and lower incisors for taking all nourishment necessary. In

such cases more time would be consumed in taking nourishment, but this obstacle is compensated for by the main points of advantage in its favor, such as cleanliness and greater comfort to the patient, as compared with the many bulky and awkward appliances in use.

Thirdly, its extreme simplicity enables any one with ordinary mechanical ability, when provided with a set of clamp bands, to easily and quickly set all ordinary cases of fracture.

And, lastly, the certainty of correct results will be sufficient reason for all those who are interested in this branch of surgery to give it a trial. Class No. 3, comprising fractures of edentulous jaws, are fortunately very rare. The method of treatment is similar in principle to that already described in class No. 1, only that in place of the teeth small bone hooks are used, drilling for their reception a suitable cavity on each side of the fracture, comparing in position to the original sockets of the teeth, the same as if the operation of implanting teeth were intended; the cavities thus made need not be nearly so large or deep. They should also be drilled obliquely, to correspond to the course taken by the hooks. The hooks before insertion should, of course, be made antiseptic. While Dr. Angle has confidence in this means of treatment for edentulous jaws, it seems evident to the writer that the interdental splint already described would be more practicable.

CHAPTER XXIX.

APPLIANCES FOR THE CORRECTION OF DENTAL IRREGULARITIES.

Orthodontia, which pertains to the correction of irregularity in the position of the human teeth, and which was given little or no attention by the earlier teachers, is now recognized as a distinct branch or specialty of dental science. To practice this field along the advanced lines requires special study, investigation, and training and it is our purpose, in the present chapter, to introduce the most important methods and principles involved, with the manner of constructing and adjusting the appliances.

Mechanical Forces.—The operator in orthodontia has an opportunity to utilize his knowledge of physics, and the laws of mechanics. As a very able writer, Dr. Eugene Talbot, says: These laws are founded upon the action of simple elements which are interposed between the moving power and the resistance, for the purpose of changing the direction of the force. These are called mechanical powers, and are divided into two primary elements, the lever and the inclined plane. The principle of the lever is the basis of the pulley, the wheel, and axle. That of the inclined plane is the basis of the wedge and screw.

Elasticity, as shown in India-rubber and the spring of metals, although not classified with the primary forces in mechanics, plays an important part in the application of force in regulating teeth. When these laws and their applications are firmly fixed in the mind of the operator, he can readily take advantage of the one which should properly be applied, or, when necessary to apply more than one, can combine them in such a manner as will best accomplish the desired result.

The most frequent forms of irregularity are protrusion of the cuspid teeth, misplaced bicuspids, contraction of the arch, protrusion of the upper jaw, protrusion of the lower jaw, torsion, and lack of anterior occlusion.

Protrusion of Cuspid Teeth.—In correcting this form of irregularity, which is possibly the most frequently met with, we have to decide from other existing circumstances whether the enlargement of the arch is indicated or the extraction of one or more teeth. If the upper arch is large enough, the simple extraction of certain teeth, in a young person, will allow nature to correct the deformity; which she will do unaided usually, by bringing the cuspids down, and back into position. In extracting teeth for regulating purposes, a mistake is frequently made in the selection of the tooth or teeth to be removed; we have, in our practice and clinical experience, met with several cases where practitioners have, at times, extracted the lateral incisors, allowing the cuspids to come forward and down, and on other occasions the cuspids have been removed. The result, in each case, has been an almost hopeless deformity. The cuspid teeth brought next to the central incisors oftentimes gives the face a canine expression, while if the cuspids are removed the countenance is robbed of that prominence near the angles of the mouth which is very necessary to harmonious expression; in fact the cuspids contribute more than any of the teeth, unless it is the central incisors, to the beauty of the mouth. In consideration of these facts it is readily seen that the practice of removing the *projecting* teeth is most injudicious.

It is a disputed point as to which of the teeth, posterior to the cuspids, can be best spared from the mouth, and for these cases no rule could be universally adopted. One must be guided entirely by the circumstances existing in each individual case. For instance, when the space between the lateral incisor and the first bicuspid is equal to, or more than one-half the width of the crown of the cuspid, and all the teeth are sound, the second bicuspid should be removed; when there is practically no space, or less than that mentioned between these teeth, the first bicuspids are the teeth to be extracted. If, however, the bicuspids are all sound, and the first molars are badly broken down by caries, the removal of the latter would be indicated, after which the bicuspids could be brought back by suitable appliances.

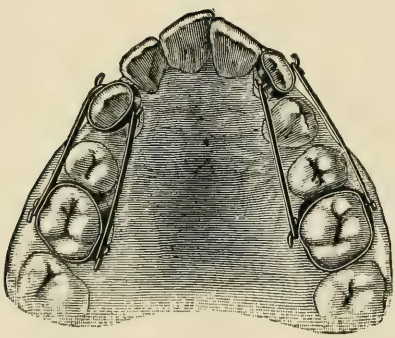
Numerous forms of appliances are employed in correcting an irregular arrangement of the teeth, as every case presents its own peculiarities. Those which, in the experience of the writer and

others, have proven most simple in construction and effectual in treatment, will be described in detail.

When teeth have been removed for the correction of irregular cuspids, and it is desired to hurry the operation, or where the bone is too hard to permit nature to move the tooth sufficiently, appliances such as are illustrated in Figs. 223 and 224 are usually employed. The first, Fig. 223, was originally described by Dr. S. H. Guilford.

A platinum band, with short gold wires soldered to the buccal and lingual surfaces, is cemented to the tooth to be moved, while a similar one is attached to a molar or other anchor tooth. The wires on the anterior band are bent forward, and those on the posterior one are curved backward. Two rubber rings, caught

Fig. 223.



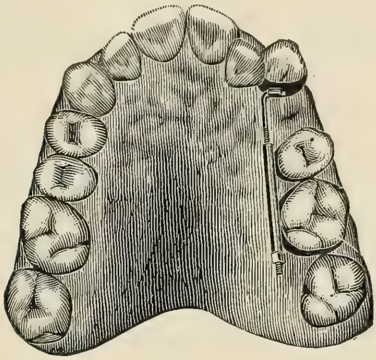
over the gold hooks, connect the two bands and yield the tractile power required. These rubber rings can be removed and replaced for cleansing the teeth, or can be renewed at will by the patient. Two rings can be attached to each pair of hooks, if greater power be required; or the same object can be attained by cutting wider rings from thicker tubing.

The second method, introduced by Dr. E. H. Angle, and illustrated in Fig. 224, is a part of what is known as the " Angle system of regulating"—one of the best, most complete, and simplest systems extant.

The first molar, or, when considered necessary, two teeth, may be encircled by a metallic band, to which is soldered a piece of tubing to accommodate the traction bar or screw. A band is also

fitted to the cuspid; to this a short tube is soldered on the palato-distal portion, into which the bent end of the traction screw-bar is

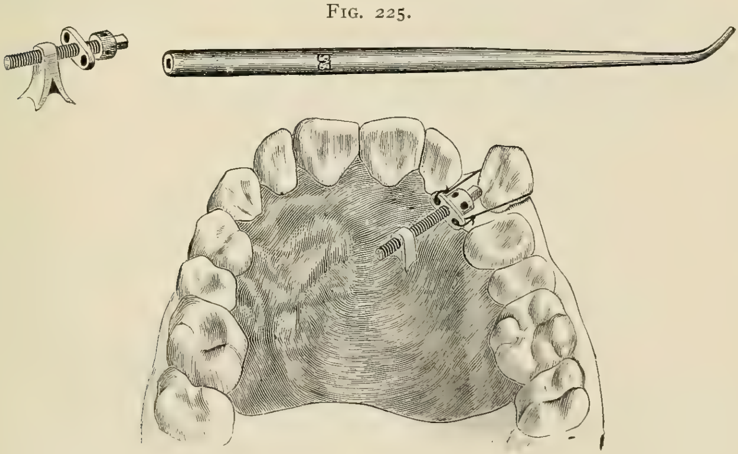
FIG. 224.



engaged. The nut, which is operated against the distal end of the tube, will readily move the tooth into position.

We sometimes meet with obstinate cuspid teeth, which refuse to drop into line after the necessary room has been secured for them.

FIG. 225.



When this is the case, an appliance, such as is illustrated in Fig. 225,—the pull-back jack-screw devised by Dr. F. H. Lee,—answers the purpose admirably.

The post or nut shown in the side cut is set in position and held by vulcanizing into a rubber plate as shown in the illustration; the screw-bolt is then placed through the post and a wire is passed around the tooth, the ends being secured to the holes in the cross-head or swivel-block. The wire is then taken up and tightened as the tooth is brought into place. To prevent the plate from being moved out of position by the strain upon it, it should be secured to the teeth of the arch by ligatures.

Correction where the Cuspid Tooth is Inside the Arch.—The power usually necessary to move an inlying cuspid is very great. The jack-screw is, therefore, one of the forms of appliances; this, however, may sometimes be aided by what is known as the inclined plane. Dr. Angle's method is shown in Fig. 226.

FIG. 226.

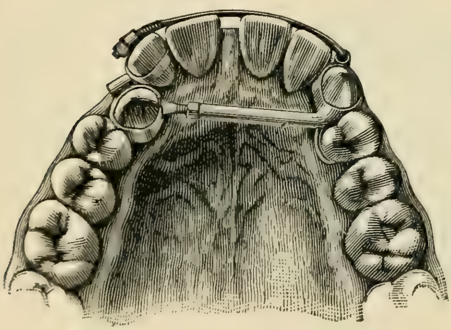
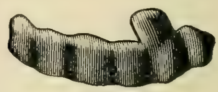


FIG. 227.

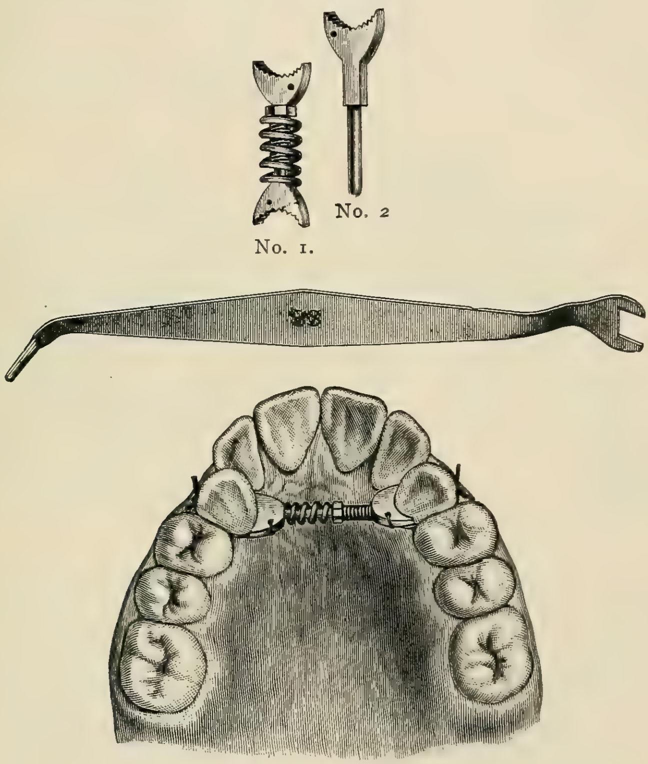


The base of the tube containing the screw-bar, or jack-screw, is soldered to a band encircling the opposite cuspid and reinforced by a spur resting against the first bicuspid (see illustration), and also by the large traction screw, which is hooked into a pipe soldered to the labial surface of the band and passing in front of the incisors through a tube soldered to a band on the labial surface of the incisors, against which the nut works. In this case, the left central and lateral were moved forward in the line of the arch, thereby closing the space between the centrals, and, at the same time, providing space for the out-moving cuspid. The large screw was beaten flat and polished before insertion.

The Inclined Plane.—One of the earliest methods employed in correcting, or aiding to do so, where the superior cuspid or in-

cisor teeth were interlocked, was what is known as the inclined plane. This is formed of metal, by first striking up a saddle to cover two or more of the lower incisors. To this, at the desired point, is soldered an inclined piece of heavy metal, so directed that when the appliance is cemented in position the inlocked tooth will strike upon it in mastication and be forced outward into line. Fig. 227 shows a form of this appliance.

Fig. 228.



Another device for the same purpose is that of Dr. T. Stanton Holmes, wherein is combined the screw and spring methods. Fig. 228 shows the appliance in position. It is operated by the nut-fitting ends of the wrench; the turning of the screw causes a forceful spring action to the extent only of the screw thrust, and so avoids the common danger of spring action, which, if neglected, may carry

the tooth too far. The screw is made by the substitution of a long head No. 2, for the short head of No. 1.

Misplaced Bicuspids.—A simple method of moving bicuspids into position when they are inside the arch is the simple jack-screw of the Angle system. Another very ingenious method is the Jackson crib and spring appliance.* Fig. 229 shows such an appliance in position. A base wire is shaped to the lingual side of the anterior teeth and anchored to the bicuspids by means of a single "crib" appliance. To each of these latter is attached a hook or eyelet to sustain a straight bar of spring wire that is sprung over the anterior teeth.

Dr. Jackson gives another very simple fixture for the purpose of

FIG. 229.

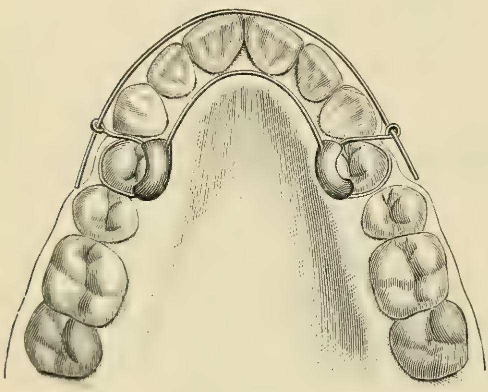
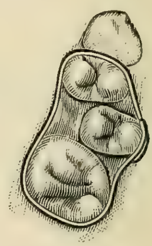


FIG. 230.



moving a single bicuspid either inward or outward. It is shown in Fig. 230.

A spring wire is bent in the form of a crib surrounding the misplaced tooth and an adjoining one on each side, passing well up toward the gum on the labial and lingual sides, with the ends of the spring wire terminating and overlapping upon the tooth to be moved. The elasticity of the spring will exert enough force to move the tooth.

Contraction of the Arch.—The enlargement of the arch by lateral expansion may be accomplished by a number of methods. Older practitioners usually make use of the Coffin split plate, but

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* Devised by Dr. V. H. Jackson, of New York.

it is the author's opinion that heavy, cumbersome appliances should be discarded as far as possible. Among the neatest and most effective for this purpose are those devised by Dr. Eugene Talbot and Dr. Angle. Dr. Talbot's method is as follows:

A vulcanite plate is made to fit the teeth and alveolar process, and cut away so that the anterior parts extend far enough forward to inclose the teeth to be moved. (See Fig. 231.) A piece of piano-wire is bent into either of the forms shown in Fig. 232, wherein *a* is the coil and fixed point; *b b*, movable arms extending from *a*, and *c c*, movable arms extending from *b b*. Grooves are cut into the anterior and posterior parts of the plate to correspond with and receive the points *b b* and *c c*. Holes are drilled at these points,

Fig. 231.

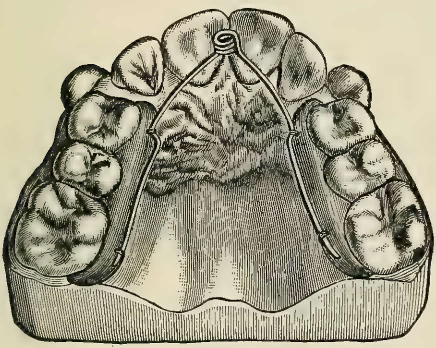
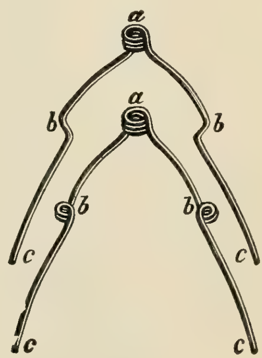


Fig. 232.



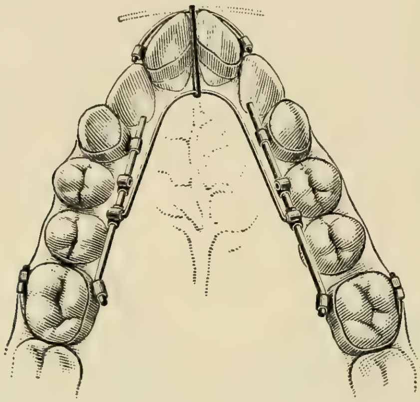
and the wires tied to the rubber plates. In order that the anterior teeth may be moved with the greatest force, the arms are so adjusted that the greatest pressure is exerted on the anterior parts of the plate. This appliance is readily removed for cleansing and returned to place by the patient.

Dr. Angle's method utilizes the principle of the Coffin spring without the objectionable features of the rubber plate. It can be used either in the upper or lower arch; and where no greater power than the spring affords is needed will prove very efficient. As seen in Fig. 233 a rubber ligature may be attached to the center of the spring and be connected with any cross-bar appliance upon the incisors for drawing them inward when such additional movement is desired.

A very excellent method of spreading the arch is that practised by Dr. C. Heydenhauss, Dentist to the Court of H. R. M., the Grand Duke of Sachsen-Weimar.

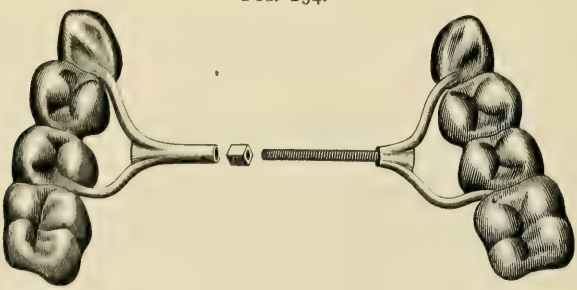
In a recent interview with Dr. Heydenhauss, he explained his

FIG. 233.



methods to the editor as given below. The Doctor has made use of the continuous gold-caps in this work, as illustrated in Figs. 234–237, for several years, and presented the same to the Odontological Society of Geneva, Switzerland. It consists, first, of capping the teeth on both sides of the mouth, from the cuspids back to

FIG. 234.

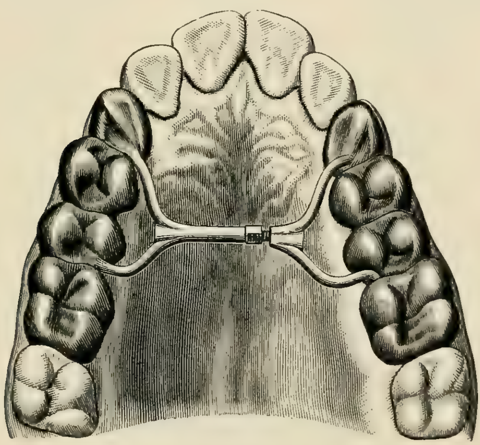


the second molars, with continuous shell-crowns. These crowns are constructed of one continuous piece of gold plate, 22-carat. The cuspid teeth, however, if they are to be forced outward, only need covering on the palatine surface. This is all clearly shown in Fig. 234. After the crowns are well fitted and fin-

ished, two platinized gold bars are soldered to their palatal surface and shaped according to the form of the palatine vault. To one side a heavy screw-bar is soldered, while to the other a short hollow tube, to receive the free end of the screw-bar, is attached. The screw-bar is provided with a nut, which, after the crowns have been securely set with cement, is turned up on the bar until moderate pressure is exerted. This nut is then given two or three turns, three or four times a week, according to the case in hand. The appliance in position is shown in Fig. 235.

When it is desirable to expand the lower maxilla, continuous crowns are made as has been directed, but to each of these an open

FIG. 235.



cylinder is soldered to the lingual surface. This is done by fitting and soldering a gold tube over a piece of piano-wire of the same size as the wire which is to exercise the traction. After this is done, the gold tube is cut in its long axis, by which we get the open cylinders. The posterior ends of these tubes are closed so as to receive the ends of the traction wire when in position. When the crowns are secured in position with cement, a piece of piano-wire, previously shaped from the cast or die, is sprung into the open tubes. To exercise the necessary traction, the wire must be slightly spread before placing it in the mouth.

The placing of this wire requires some skill, but is, however, easily understood. To prevent oxidation the wire can be gold

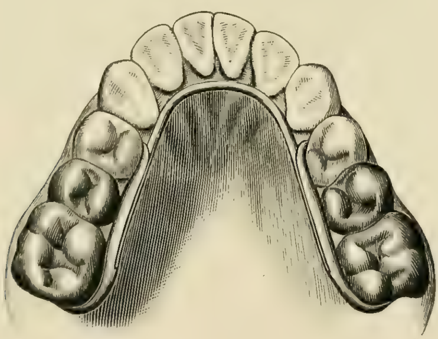
plated. The wire should be taken out every two or three days and slightly expanded, then replaced. This appliance is shown in Figs. 236 and 237.

Protrusion of the Upper Jaw.—One of the most efficient methods of reduction in superior protrusion is that given by Dr. Angle.

Fig. 236.

It consists of anchor bands (D, Fig. 238) for the molar teeth, with long tubes soldered to their buccal surfaces to receive the wire bow-spring, which rests in front in notched projections upon the bands cemented to the central incisors. At the center of the bow-spring is soldered a short tube, having upon its labial surface a rounded projection to receive the standard (cupped at its free

Fig. 237.

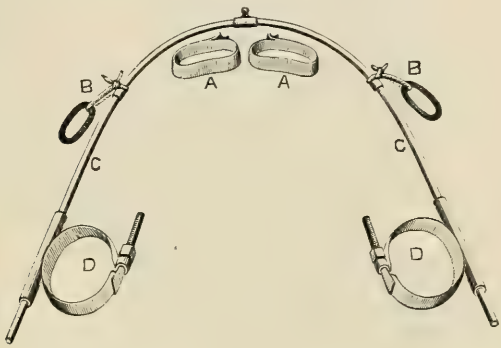


end) of the long traction bar, Fig. 239. In use, the clamp bands (D) are attached to the anchor teeth, and the plain bands (A, A) cemented to the central incisors. The bow-spring is now placed in position.

Occipital resistance is obtained by means of a netted cap, fas-

tened to a circle of wire fitted to the head, to which are attached rubber bands. When the cupped standard of the traction bar has been placed over the central spur of the bow-spring, the rubber bands of the cap are drawn forward and looped over the curved ends of the traction bar, as shown in Fig. 240. This cap, traction bar, and rubber bands, are worn only at night, on account of their

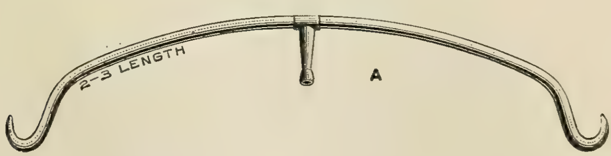
FIG. 238.



conspicuousness. During the day, rubber rings (B, Fig. 238) are caught over the tubes on the molar bands and secured by ligatures to projections on the bow-spring in the region of the cuspid teeth. The appliance in position, as worn during the day, is illustrated by Fig. 241.

After reduction of anterior protrusion we are met with the difficulty of retaining the results gained. Although the posterior teeth

FIG. 239.



in many cases will not furnish the resistance necessary for drawing the anterior teeth inward, they will usually answer perfectly for retaining them afterward. Attachment can be made to them either by means of a rubber plate covering the roof of the mouth and extending around their distal surfaces in the form of a clasp, or by means of metal bands or caps cemented to them. In the former

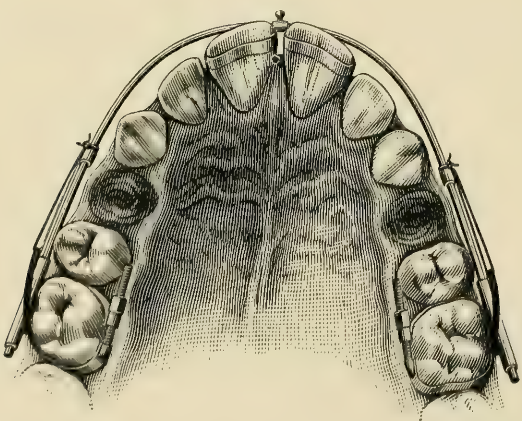
case, a small round, or half round, gold wire may be made to pass around the arch, touching the regulated teeth on their labial sur-

Fig. 240.

Night appliance.

faces, and be attached at each end to the rubber plate at convenient points—as where teeth have been extracted. In the latter case, a

Fig. 241.



similar retaining wire may be soldered to the molar bands, or the

bands may have tubes soldered to their buccal surfaces and the wire, threaded at the extremities, passed through these and retained by means of nuts operating upon them. In either case, the retaining wire should have short gold clips attached to it in front to engage with the cutting edges of at least two of the incisor teeth.

When it is desired to avoid having a retaining wire pass entirely around the front of the arch, a rubber retaining plate may be made with a gold T passing between the centrals, and long enough to rest upon all four of the incisors. Holding these teeth firmly in place will also keep the cuspids in line through lateral pressure.

The principal appliances of the Angle system are manufactured and kept in stock at the dental depots. There are certain portions, however, which have to be united or soldered to suit the case in

Fig. 242.

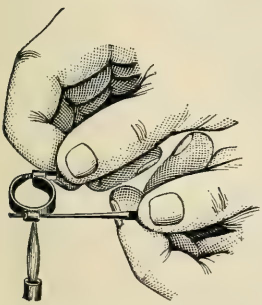
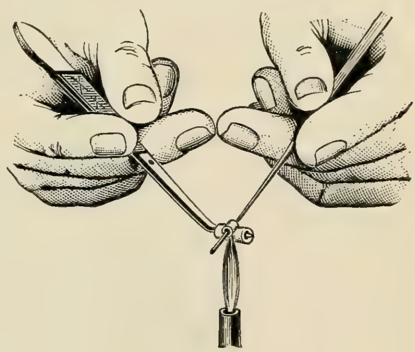


Fig. 243.



hand, and as these fixtures are made as light and delicate as possible, some care is required in handling them.

In uniting the parts of the appliance with solder, a fine, sharp flame from a Bunsen burner is most desirable, as both the hands are free and can be used in holding the pieces. Notwithstanding many ingenious spring clamps and devices have been invented for holding such small work while soldering, yet the method of holding them with the fingers is greatly to be preferred, as it is much easier and simpler, steadying the hands by touching the fingers together, as shown in Figs. 242 and 243.

In writing of this subject, Dr. Angle says:

"The small tubes are best held by slipping them on to the end of an excavator shank, or, what is just the ideal, one of Gates'

nerve drills after the cutting point has been broken off. It is so slender that but little of the heat is absorbed. Two of these handles may be employed when a couple of the small tubes are soldered, or the pliers may be used for holding one of them. (See Fig. 243.)

"I should judge it not difficult to learn this method of soldering; the only point which at all may perplex the beginner is to hold the pieces immovable just at the time solder is congealing, but this can be done by touching the fingers of the opposite hand in order to steady and prevent all motion at the point of union, and at the same time holding the pieces gently, *not rigidly,* just as a good penman holds a pen. After a little, any of the combinations may be easily made in a very few minutes. Where the ends of small tubes are to be secured, it is best to first fuse the solder upon the band, and then hold the small tubes, by means of the soldering pliers, in contact with the solder and again apply heat, otherwise the solder will be drawn into the tube. The solder best adapted in uniting the different parts of these appliances is the ordinary jeweler's silver solder, although 18-carat gold solder may be used. Plenty of borax should always be used as a flux. Scrape bright the silver solder and the points to be soldered, and borax both. Never use more solder than is necessary, especially in attaching the small tubes; use just sufficient to make the union.

"Always avoid overheating; just enough heat from a small flame to thoroughly fuse the solder is all that should ever be employed. In every instance avoid heating the screws or nuts. This is to be especially observed with the jack and traction screws, as great care is observed in their manufacture to produce the greatest stiffness and strength, and this fine temper is ruined by heating."

Protrusion of the Lower Jaw.—When this deformity is slight, it may usually be corrected by drawing the lower incisors in and the upper ones outward. Where the case is a pronounced one, there is no remedy except the retraction of the entire lower jaw. In many cases, however, the two measures can be combined to advantage.

Method of Retraction.—It was for many years supposed that the retraction of the inferior maxilla was brought about entirely by a change effected at the angle of the jaw; but some years ago it was noticed by Prof. C. N. Peirce that where sufficient pressure

was brought to bear a change was brought about in the temporo-maxillary articulation. That is, if pressure was continued at the mental region, it would cause resorption of the posterior wall of the glenoid cavity, thus permitting the condyles to recede, and articulate somewhat posteriorly to their former positions.

Through this fact, and the change that is brought about at the angle of the jaw, we are enabled to correct one of the most unsightly of dental deformities. The method of procedure is well illustrated by a case brought before the Odontological Society of

FIG. 244.

New York by Dr. Geo. S. Allen. He says, in part: "As will be seen from the photograph (Fig. 244), taken at the time the patient was wearing this apparatus, it consists of two parts. For the lower part I made a brass plate to fit the chin, having arms with hooked ends reaching to a point just below the point of the chin. These arms were arranged in such a way that the distance between them could be altered at will by simply pressing them apart or together. The upper part consisted of a simple network, going over the head and having two hooks on each side, one hook being above and the other below the ear. When this apparatus was

completed and in use, there were four ligatures of ordinary elastic rubber pulling in such a way as to force the lower jaw almost directly backward. The work proceeded very rapidly, so that at the end of two months the irregularity was almost entirely cured."

A very good method of making the chin piece is that described by Dr. Guilford. Take impression of the chin and from this make a model. The model is then overlaid with a piece of trial-plate wax, from which, after being varnished, a mold in sand is obtained and a die and counter-die made. Between these a piece of soft and heavy brass plate is struck up and drilled full of holes. After fashioning heavy piano wires to cross the plate and extend sufficiently beyond to form hooks, they are soft-soldered to the brass plate and the latter covered with black silk, with a thick layer of cotton batting laid between the two.

The enlarged size of the chin piece will admit of this. The piece

FIG. 245.

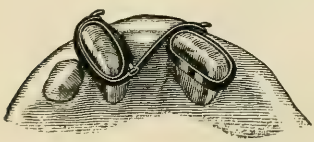


FIG. 246.

thus padded will fit the chin and be soft enough to prevent pain when pressure is brought to bear upon it.

Torsion.—The term torsion, when applied to the teeth, signifies that condition in which a tooth is found to be turned upon its axis. Rotation refers to the act of turning a tooth so as to bring it into normal position. Torsion, therefore, describes the condition, while rotation refers to the operation.

Rotation by Rubber Rings.—In the accompanying illustrations, Figs. 245 and 246, Dr. Guilford's method of employing bands and rubber rings for rotation is given. Platinum bands were fitted to the centrals, with a gold hook soldered to each at points that would furnish the greatest amount of tractile power. After the bands were cemented in place a rubber ring was stretched from tooth to tooth, in the manner shown in Fig. 245. The malposed tooth was thus readily brought into contact with its fellow, and at the same time considerably straightened. After which it was retained by the retainer shown in Fig. 246.

Rotation by Spring Bar.—When the mesial angles protrude, double rotation can be accomplished by the very simple and effectual method recommended by Dr. Angle.

Upon each of the teeth to be rotated place bands with tubes soldered to their labial faces near the distal angles. One tube is set vertically and the other horizontally. A soft piece of piano or German silver wire, bent to a right angle at one end, is inserted in these tubes, and rotation is effected by the elasticity of the wire (Fig. 247). Once in position, the teeth are retained by inserting in the tubes a suitably shaped piece of non-elastic gold wire, as shown in Fig. 248.

Lack of Anterior Occlusion.—This form of irregularity is fortunately rare, as it is one of the least amenable to treatment. The cause is usually the lack of alveolar development in the anterior portion of the mouth, sometimes accompanied with an excessive growth in the molar region.

Fig. 247.

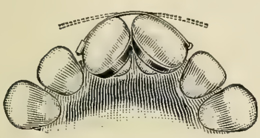
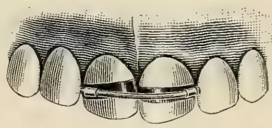


Fig. 248.



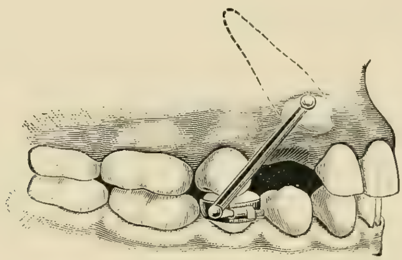
Treatment.—When the deformity is slight it may be corrected by grinding off all the antagonizing points from the posterior teeth, which will shorten the bite, bringing the anterior teeth closer together. If the third molars were in position and adding to the trouble they should be extracted. Then, if necessary, one or more of the remaining molar teeth upon either side of the mouth (those in the poorest condition to be selected) may be devitalized, ground down beyond the point necessary, and then covered with gold crowns.

Where considerable grinding upon vital teeth is done and the exposed dentine becomes quite sensitive, it may be obtunded by a repeated application of either chlorid of zinc or nitrate of silver.

Unusual Forms of Irregularities.—The following cases of unusual forms of irregularities, illustrated in Figs. 249, 250, 251, and 252, were treated and described by Dr. Angle. The first, Fig. 249, shows the manner of bringing a cuspid tooth out into line, that is,

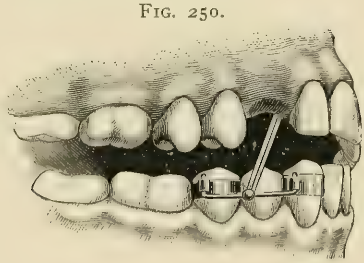
aiding it to erupt. The clamp band was fixed on the lower second bicuspid. A very small hole was drilled into the cuspid, and a short pin was set with thin cement. A common pin answers the purpose, and the hole need not be deeper than the enamel if the pin is accurately fitted to it. A rubber ligature was given the patient, with instructions to slip it over the pins, as shown in the

Fig. 249.



engraving. The anchor tooth in this case is directly opposed by the superior bicuspid. The anchorage is simple and efficient. The ligature may be worn at night only, so as to interfere as little as possible with speech and mastication, although some patients wear it almost continuously. Too strong a ligature should not be worn, as it might endanger the life of the pulp, but gentle traction should be used, gradually directing the tooth into its proper position.

Fig. 250.

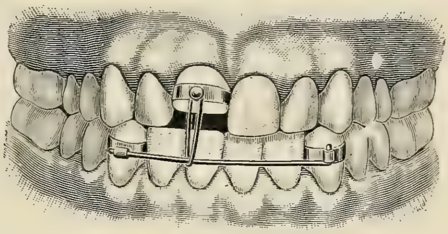


The direction of force to be exerted upon the tooth to be moved will, of course, indicate which tooth in the inferior arch should be selected for anchorage. Should the anchorage fall upon a tooth with no antagonist there would, of course, be danger of loosening it.

Fig. 250 shows a case in which the anchorage was modified to suit the conditions. A deciduous cuspid had been retained too

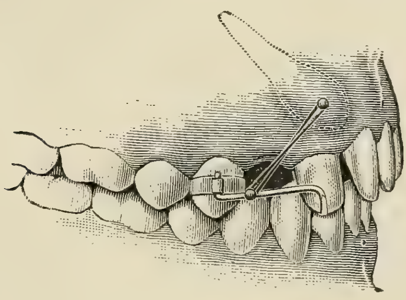
long, causing the permanent cuspid to remain in the alveolar process on the palatal side of the lateral incisor, necessitating a complex movement of the tooth backward, outward, and downward, requiring a very firm anchorage and a strong ligature. On the inferior cuspid and second bicuspid were fixed bands, having

FIG. 251.



pipes attached to their labial surfaces. A piece of the wire of suitable length was bent at right angles and hooked into the pipes, as shown. The wire fits the bore of the pipe so accurately that in cutting off the ends which emerge through them, each end spreads sufficiently to prevent its coming out. A pin was soldered to the

FIG. 252.



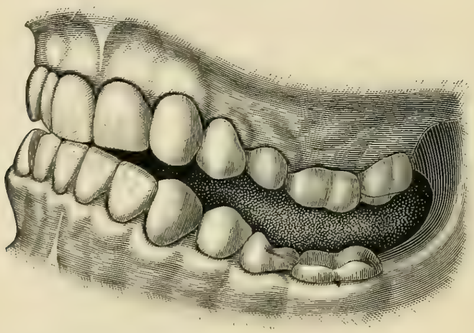
wire about midway between the pipes. The ligature was stretched from pin to pin, as seen in the engraving.

Fig. 251 shows a modification of this method of anchorage. The anchor wire was made detachable and the pin dispensed with, the patient slipping the wire through the ligature and into the pipes upon retiring, and removing it during the day. A delicate band, to which was soldered the pin, was fixed on the moving tooth.

Fig. 252 illustrates a case in which the appliances used were similar to those before described, but the wire anchorage was attached to teeth in the same arch in which was located the malposed tooth. The first bicuspid was banded and a pipe soldered to the labial surface of the band, in which was hooked a piece of the wire, the other end of the wire being bent so as to rest on the cutting edge of the lateral incisor. A pin was soldered to this wire, as in the case before described, and a rubber ligature stretched from pin to pin.

Regulating Supplemented by Crown-work.—An interesting case treated, and reported in the *Dental Cosmos,* by Dr. F. M. Willis, is that of a young lady who, several years previous to treatment, had the left superior lateral incisor and right first bi-

FIG. 253.



cuspid extracted by a dentist to correct a slight irregularity. The result was that instead of remedying the condition, there was a general settling in of the entire upper jaw, resulting in a much worse condition than the first. The right superior central incisor was the only one of the upper teeth that touched the lower. There was a space of ¼ of an inch between the upper and lower bicuspids and molars when her jaws were brought together. (See Fig. 253.)

The patient was unable to masticate her food properly, and as a natural consequence she was suffering from indigestion so badly that she was unable to attend school, and her system was very much run down.

A split plate, with a piano wire spring, was made to spread the upper bicuspids and molars. The patient wore this appliance for

six weeks, calling once a week to have the spring opened as the case progressed. The upper molars and bicuspids were now directly over the corresponding teeth of the lower jaw, having been spread about $\frac{1}{4}$ of an inch.

The cuspids occupied about the right position, so the next step was to move forward the centrals and lateral incisor. A gold band was fitted around the right central, with a spud resting behind the other central and the lateral incisor. The left central and the lateral incisor were somewhat twisted on their axes, so the spuds resting behind them were bent so as to twist these teeth as they moved forward. A plate was made, covering the molars and bicuspids, with a piano wire spring resting in a notch in the gold band behind the right central. This appliance was worn for a month. The incisors were now straight on their axes, and were far enough forward to allow them to shut outside the lower teeth. Now when her jaws were closed there was less than $\frac{1}{16}$ of an inch space between the bicuspids and molars of the upper and lower jaws.

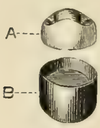
The lower molars and bicuspids were badly broken down from decay, some of them having been filled half a dozen times. To put them in good condition and raise their grinding surfaces to articulate with the upper teeth, it was decided to crown them with gold. The molars were capped in the usual way with gold crowns.

In order to avoid too much show of gold on the bicuspids, a new method was resorted to in crowning them. A gold band was fitted around the tooth, extending about $\frac{1}{16}$ of an inch above the end of the tooth. An impression and bite were taken at the same time by covering the tooth and band with plaster and closing the jaws while the plaster was soft. The band and plaster were removed intact, and Melotte's fusible metal poured into the band and a pin stuck into the metal to hold in the plaster. The crown was placed on the articulator, and the bite completed with Melotte's metal and plaster. The plaster was now removed from the band, leaving a metallic surface $\frac{1}{16}$ of an inch below the top of the band, against which to fit a porcelain top for the crown. In this case an ordinary plain tooth, such as is used in vulcanite work, was selected and ground to fit into the gold band and the right length to articulate with the upper teeth. This porcelain tip was cemented

into the gold band, and the whole removed from the articulator. The fusible metal was heated a little, and readily came away from the crown. Fig. 254 represents the finished crown.

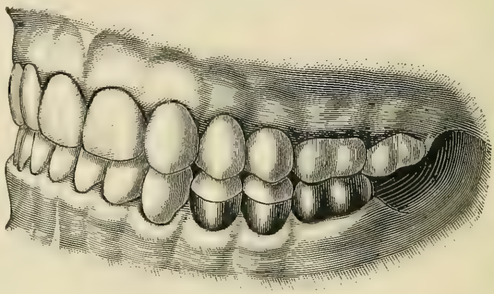
These crowns were cemented on in the mouth and produced a nice appearance, as nothing but the porcelain showed when the mouth was opened, the lip and tongue entirely hiding the gold

FIG. 254.



A. Porcelain tip. B. Gold band.

FIG. 255.



band. A crown of this description is particularly advantageous for the lower molars and bicuspids, especially where they need to be brought up some distance above the natural tooth.

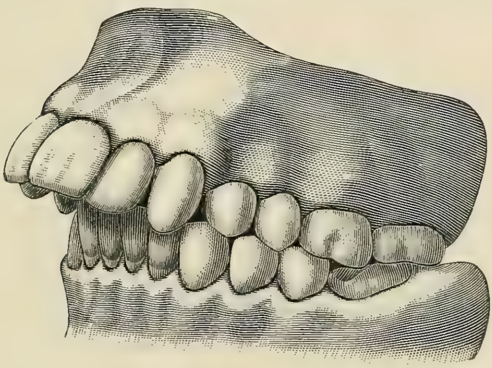
Such a crown can be made, with absolute accuracy, in one hour, and there is no risk of a fractured porcelain, as no heat is used.

Fig. 255 represents the case completed.

Reposing the Features in Orthodontia.—The science of orthodontia, under the influence of modern methods of practice and improved appliances, is now claiming a distinct field in dental art and mechanics, embracing the esthetic contours of the face as well as the movement and rearrangement of individual teeth. In the ordinary practice of this branch of dentistry, not enough attention has been given to facial effects; the aim usually being simply to bring the teeth to a more perfect occlusion, with little regard to the movement of the roots, and the surrounding bony structure. In examining dental literature, little is found in regard to the movement of roots, and methods by which it may be accomplished; and it was not until Dr. Calvin S. Case presented his paper at the World's Columbian Dental Congress that much of practical value in the development of esthetic facial contours was established.

To illustrate the possibilities in the treatment of dental irregularities, we present an interesting case from among those we have recently treated. It is that of a young man of eighteen, whose mouth presented a very homely appearance. The upper jaw was contracted upon the sides and very prominent in front, with very large, protruding incisors and cuspid teeth. The median line of the face, too, was nearly the width of a central tooth to the left, giving the jaw a twisted appearance, as though the teeth had been forced over in a body to the right. Fig. 256 gives a fair idea of the appearance of the mouth when the work was commenced. A bicuspid was extracted upon either side. The left cuspid was then drawn back to the position formerly occupied by the first bicuspid

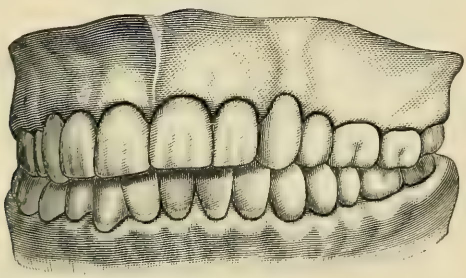
Fig. 256.



by an appliance similar to that illustrated in Fig. 223, page 436; then the lateral incisor was brought over to the left, which was followed by the centrals; in this way the center of the teeth was brought nearly to the median line of the face. The next procedure was to band the molars and bicuspids upon either side, upon the buccal surface of which a hook was soldered, directed backward; a gold cap was then made with hooks directed forward, and cemented upon the central incisors. Rubber bands were then brought from the posterior hooks to those in the front of the mouth. Very light bands were employed at first, which were gradually increased in width and strength as the teeth moved inward and backward. While this was being done a light jack-screw (of the Angle system) was worn in the mouth, bringing pressure upon the second bicus-

pids and molars, which gradually enlarged the arch, helping to fill out the face upon the sides and giving the anterior teeth more of an opportunity to move backward. After the anterior teeth were drawn back as near to the normal position as we could bring them, the pressure was relaxed by substituting much lighter bands, which, with the jack-screw across the palate, were worn for several months. When these fixtures had been removed, the lateral incisors, which were turned slightly upon their axes, were rotated by the means of ligatures, and a gold cap, covering the lower half of the six anterior teeth, was made and cemented in position. This was worn as a retaining appliance for six months. The results, which were most gratifying, may be seen by comparing Figs. 256 and 257. One of the most interesting points in relation to this case is that the work was completed without destroying

FIG. 257.



the vitality of any of the teeth, which is too often the case where heavy, cumbersome appliances are employed and the teeth moved too rapidly. While the retaining appliances were being worn, the third molars were erupted as can be seen by referring to the illustrations.

Dr. Case's Methods.—From the paper referred to above we have selected three of the most interesting and pronounced cases. In this connection Dr. Case states that he is now able to correct, with perfect certainty of success, any marked depression or protrusion of the upper lip which is mainly due to a malposition of the *roots* of the incisor teeth; and further says:

" Instances are often observed among the youth who demand our professional services which show a comparatively perfect alignment and occlusion of the teeth, and yet because of the position of the

roots, with a consequent abnormal depression or protrusion of the adjoining bone, considerable imperfection of features and external contour of the face is produced. These deformities are peculiar and not common, but have rarely engaged attention with a view of orthopedic treatment directed to the development of a more esthetic facial form. In the instance of a marked depression of the upper lip, as in Cases 1 and 2, they are often mistaken for a prognathous lower jaw, because of the lack of proper fullness in the central features of the face, which frequently affects the shape of the nose and deepens the lines on either side. For the same reason the cheek bones will at times appear abnormally prominent, giving to the face a broad and flattened appearance, especially if the cuspids, being retarded in their eruption for the want of room, take a more lateral and prominent position. If the lower teeth are in proper relative position and the deformity caused, as is most common, by the lower incisors occluding in front of the upper, every change desirable may be effected by an appliance attached to the superior teeth alone. As an illustration of this, I call attention to the models in Case 2.

"On the other hand, if the entire superior dental arch is narrow and contracted, with a high palatal dome, the teeth long, uncrowded, and not materially affected in position by occlusion, the face will usually be long and narrow, the nose prominent, thin, and of the Roman type (see Fig. 264, Case 1). In these cases the entire dental arch and alveolus should be expanded, and the force so applied and controlled as to retain the teeth in an upright position, especially in the process of carrying the anterior teeth forward, which is of vital importance in the restoration of the features of the face. The principal force, therefore, should be exerted upon the anterior superior teeth; and this force may be reciprocated by rubber bands extending from the posterior part of the upper appliance to the anterior part of an appliance that is attached firmly to all the lower teeth. These bands can be made to exert almost any desired force, according to the heft of the tubing from which they are cut; and their positions being such as not to interfere with mastication, they can be worn continuously.

"If the inferior dental arch is large, with the teeth occluding outside of the alignment of the superiors, it may be reduced in

size by the extraction of a bicuspid on either side and the anterior teeth forced back to fill the space (see Case 1, Figs. 264 and 265). If, however, the chin is abnormally prominent below the incisive fossæ, teeth should not be extracted from the lower jaw, the principal change to correct the facial deformity should be accomplished on the upper jaw.

"I have abandoned all attempts after early childhood to reduce a prognathous lower jaw by external pressure upon the chin, never having derived the same satisfaction from this operation that others claim. I find, however, that the rubber bands before mentioned, extending from the upper to the lower appliance, can be made to exert all the force the patient can stand at the glenoid fossæ, and doubtless this influence tends to force the lower jaw to a more posterior position. Examples of deformities of this character and their treatment are shown by Cases 1 and 2, which were selected for the purpose of showing the varieties of protruding lower jaw and teeth.

"On the other hand, with equal facility, I am able now to reduce a protrusion of the upper lip at that point where it merges into the nasal septum and orifices, when due to a malposition of the roots of incisor teeth alone, causing an abnormal prominence of the anterior nasal spine and incisive fossæ. (See Case 3.) This position of the roots of the superior incisors is not uncommon, even when the antagonizing ends are in perfect position; and often with the production of quite a marked facial deformity.

"In like manner I am able to force the anterior *inferior* teeth bodily forward, with the entire alveolar ridge in which they are imbedded. Instances are not rare where the point of the chin, the upper lip, and the anterior superior teeth are relatively in proper position, but with inferior teeth, from various causes, so posteriorly placed as to produce an abnormally deep depression or curve in that portion of the lower lip along the line of the incisive fossæ. By forcing the anterior inferior teeth forward, with the alveolus in which they are imbedded, a more esthetic shape will be given to the chin; and this change, though slight according to measurement, will often produce an improvement in the general appearance of the face that is quite remarkable. The same is true, also, in a posterior movement of the inferior incisor teeth and alveolus, when

they are so anteriorly placed in relation to the point of the chin as to obliterate the graceful curve of the lower lip. This is shown in Case 1.

* * * * * * * * * * *

"Before describing the peculiar construction of the contouring apparatus I use in these cases, I wish to say that I endeavor to have all regulating appliances made as substantially and finished as perfectly as a piece of jewelry. The bands are fitted to the natural teeth with as much perfection—especially where they extend under the free margins of the gum—as a band for a crown. I use German silver principally, and heavily gold-plate the apparatus before attachment.

"The limited area upon which force can be applied to a tooth, compared to that portion covered by the gum and imbedded in a bony socket, has made it next to impossible, with all ordinary methods, to move the apex of the root in the direction of the applied force; nor could this ever be accomplished with force exerted in the usual way at one point upon the crown, however near the margin of the gum it be applied, for the opposing margin of the alveolar socket must receive the magnitude of this direct force, and in proportion to its resistance it will become a fulcrum exerting a tendency to move the apex of the root in the opposite direction.

"But if, in the construction of the apparatus, a static fulcrum is created independent of the alveolus at a point near the occluding portion of the crown, while the power is applied at a point as far upon the root as the mechanical and other opportunities of the case will permit, the apparatus becomes a lever of the third kind, the power being directed to a movement of the entire root in the direction of the applied force."

This proposition is made plain by reference to the diagrams. In Fig. 258 let A be a point upon a central incisor at which force is applied in the direction indicated by the arrow, then will the opposing wall, B, of the alveolar socket near its margin receive nearly all of the direct force; and in proportion to its resistance will there be a tendency to move the root in the opposite direction. This proposition will also hold good even if we apply the force at A, Fig. 259, or as far upon the root as may be permitted by attaching a rigid upright bar, C, to the anterior surface of the

crown; the only difference being that we distribute the direct force over a greater area. But if, as in Fig. 260, we attach to the lower end of C a traction wire or bar, F, and further enforce the mechanical principles of our machine by uniting its posterior attachment to the anchorage of the power bar, P, we will have neutralized our anchorage force materially and created an independent static fulcrum at D. Our apparatus now will distribute

FIG. 258.

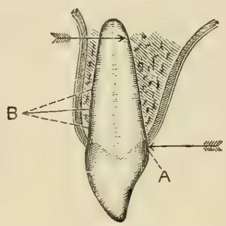
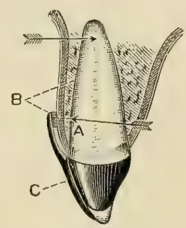
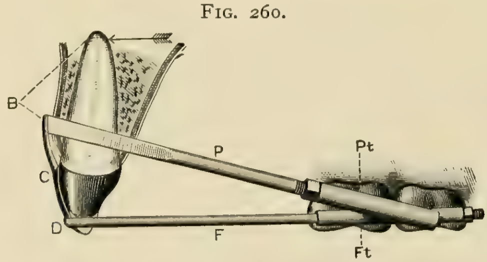


FIG. 259.



its force over the entire root, and give us complete direction and control of whatever power we put into it. The entire tooth can be carried forward bodily, or either end can be made to move the more rapidly. The force thus directed to the ends of the roots will have an increased tendency to move the more or less yielding and cartilaginous bone in which they are imbedded.

FIG. 260.

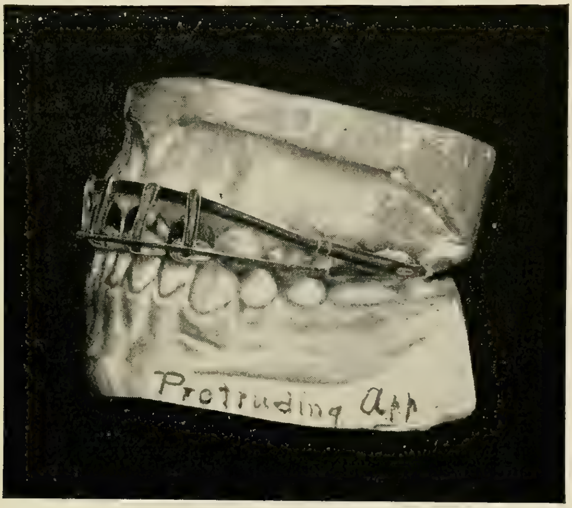


An apparatus for moving the roots of the anterior teeth in a posterior direction, as in Case 2, is constructed quite similarly, the direction of the two forces being reversed. See Fig. 261.

Protruding Apparatus.—In constructing an apparatus for forcing the roots and adjoining bone of the anterior teeth forward, wide German silver banding material for the teeth should be selected, that is, $\frac{5}{1000}$ or $\frac{6}{1000}$ of an inch in thickness. This

should be fitted to the crowns of the anterior teeth near the margins of the gum, perhaps extending beneath the margins on the proximal sides. Then bars of No. 15 B. and S. G. wire, slightly flattened, should be soldered to each of the bands in an upright position, and bent so as to lie along the anterior surface of the crowns from the apex to where the bars join the band; here they should take a direction somewhat parallel to the gum, but free from the surface to about $\frac{1}{16}$ of an inch above its margin, at which point they should be flattened or thinned, so as to be more easily

Fig. 261.



Protruding apparatus in position.

bent forward, and firmly clasped around a rigid bar which is made to extend from anchorage tubes attached to the posterior teeth. See Fig. 261.

The upright bars are now made of slightly heavier material, and made to rest in front of the power bar, and cut off even with its top edge, when they are thinned and rounded, as shown in the illustration.

This bar, which should be very rigid, is drawn without annealing from a No. 9 extra hard German silver wire to No. 15 B. and S. G. The ends are threaded in the No. 4 hole of the Martin screwplate, and the central portion is slightly flattened in the rollers.

Then it should be bent so as to rest when in proper position in the unclasped ends of the upright bars that have been left open to receive it. Before placing it in position, the nuts should be screwed on to work at *the anterior ends* of the tubes.

This apparatus can be made to exert an exceedingly powerful force, but if put into practical use as it now stands, the ends of the roots and the adjoining bony structure would not be forced forward, notwithstanding the fact that the power is applied directly to the roots somewhat above the crevices. The crowns and the body of the roots, with a portion of the alveolus only, would be moved forward.

To complete the apparatus, therefore, the fulcrum should be removed from the anterior alveolar plate and placed so that the power can be applied between it and the ends of the roots to be moved. In other words, the crowns should be restricted or controlled in movement so that the applied force may be directed to the roots alone.

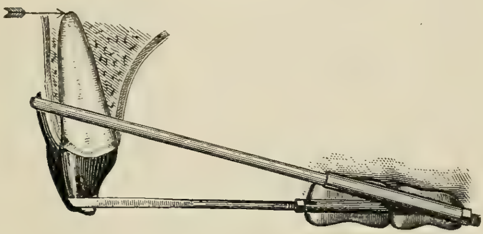
This is accomplished by a second bar much smaller and thinner than the first, but proportionately rigid, which rests in depressions in the upright pieces along the occluding ends of the teeth. The ends of the fulcrum bar are threaded and passed through tubes that are soldered to the anchorage bands on each side below the power bar tubes, with nuts which work posteriorly to the tubes.

Retruding Apparatus.—An apparatus for reducing a prominence of the features by exerting a posterior force upon the roots and alveolus of the anterior teeth, is constructed in a similar manner to the one just described, with the following exceptions: (1) The bands should be fitted to the crowns of the incisors near their occluding ends, for the purpose of obtaining a more rigid bearing in the changed application of force. (2) The lower ends also of the upright pieces should be made to clasp the fulcrum bar. (3) The nuts should be reversed in their relative positions to the tubes. (4) The most difficult and equally important part of our task will now consist in moving the roots of the cuspids, if they are prominent, but their position is such if much force is applied with the present arrangement of the apparatus, the bars will slip through the clasps at the ends of the upright pieces. Therefore some provision should be made to prevent this, which may be accomplished by short sections of pipe clasped around and soft soldered to the bars.

The most modern method of constructing the retruding apparatus is well shown in Figs. 262 and 263.

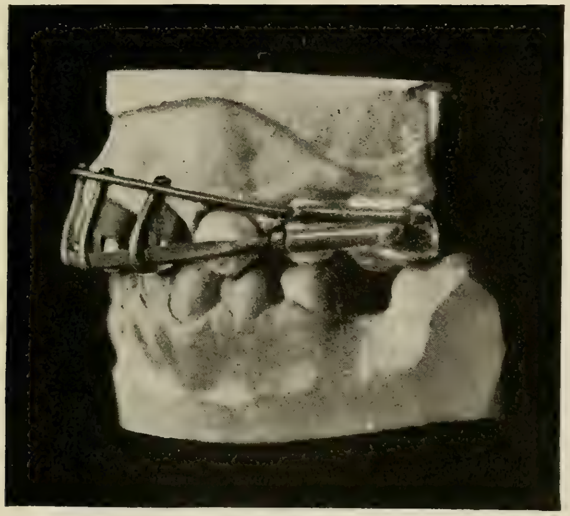
In considering the mechanical qualities of the contouring ap-

FIG. 262.



paratus outlined, we wish to direct attention to the fact that the force expended at the anchorage attachments is largely neutralized by the reciprocating influence of the two forces, and this

FIG. 263.



Retruding apparatus in position.

reciprocation is always equal to the power used on the fulcrum bar in preventing a movement of the occluding ends of the crowns. The balance of the power, which may be considerable

Fig. 264.

November, 1892.

Fig. 265.

April, 1893.

Case I.—Half-tone copies of photographs of plaster casts, made before and after completion.

FIG. 266. FIG. 267.

November, 1892. April, 1893.

Model from occlusion impression.

FIG. 268. FIG. 269.

After extraction of inferior bicuspids.

FIG. 270. FIG. 271.

CASE I.—Notice the upright position of the superior teeth in Figs. 267 and 269, notwithstanding the expansion and extension of the arch as shown in comparing Figs. 270 and 271.

Fig. 272.

November, 1892.

Fig. 273.

June, 1893.

Case 2.—The entire operation in this case was accomplished with appliances attached to the superior teeth alone.

FIG. 274. FIG. 275.

November, 1892. June, 1893.

FIG. 276. FIG. 277.

FIG. 278. FIG. 279.

CASE 2.—Notice the deep incisive fossæ and the posterior position of the superior incisors and alveolus, as shown in Figs. 274, 276, and 278, and compare with Figs. 275, 277, and 279; the upright position of the incisors; the forward movement of adjoining bone.

Notice also, in this and other cases, the occlusion of the posterior teeth, before and after treatment, showing that nearly all change has been produced anterior to the bicuspids.

Fig. 280.

April, 1893.

Fig. 281.

August, 1893.

Case 3.

in the general movement of the parts, must be sustained by the anchorage teeth, if not further neutralized by other auxiliaries.

When the central features of the face are depressed, with anterior superior teeth occluding posteriorly to the lowers, accompanied with the usual real or apparent prognathous lower jaw, great reciprocating force may be beneficially obtained from the rubber bands before mentioned. Rubber rings are cut from a ⅜ of an inch rubber regulating tube of good heft, and passed over the projecting ends of the anchorage tubes on the upper appliance to buttons on a lower appliance, opposite the first bicuspids. The

FIG. 282. FIG. 283.

April, 1893. August, 1893.

CASE 3.—In this case the roots, as well as the crowns, of the superior incisors have been forced to a more posterior position, reducing the prominence of the nasal spine of the superior maxillary and an exceedingly unpleasant fullness of the upper lip where it merges into the nasal septum. See Figs. 280 and 281.

latter appliance may be so constructed that the force will be distributed to all the inferior teeth, and indirectly to the jaw, forcing it to a more posterior position. Or it may be that the first bicuspids have been extracted, as in Case 1, for the purpose of forcing the six anterior teeth back. In either case the elastic force of the rubber bands can be made to do effective work to the full extent of their power on both the upper and lower jaws, neutralizing force which otherwise would be expended upon a static anchorage. In writing of this apparatus, Dr. Case says:

"They are useful also as an auxiliary to the reduction of a prog-

nathous upper jaw by reversing their attachments. In these cases I also make use of the occipital force, largely for the advantage I obtain in forcing the anterior teeth further into their sockets. Cases of prognathous upper jaw with protruding teeth are rare in which there is not an abnormal prominence at the base of the nose of the bones that sustain the septum and wings of the nose. When force is applied to the crowns alone of the anterior teeth, this prominence may become more pronounced, even though the position and appearance of the teeth and the face are improved by the operation.

"In these cases, therefore, I consider it quite as important to move the roots as well as the crowns of the anterior teeth, when by so doing I find I am able to remove the entire deformity, and greatly improve the general form of the face, as seen in Case 3.

"In giving a history of the cases I shall not enter into a specific description of the methods employed in each particular case, but will allow them 'to speak for themselves.'

"*Case 1.*—Ruby S., aged fourteen, commenced treatment November 22, 1892. Final models made April 25, 1893. Correction completed.

"*Case 2.*—Phœbe B., aged thirteen, commenced treatment November 29, 1892. Final models made June 3, 1893. Correction completed.

"The entire change in this case was accomplished with the contouring apparatus on the upper teeth alone without auxiliaries.

"*Case 3.*—Helen S., aged thirteen, commenced treatment April 5, 1893. Final models August 13, 1893. Correction incomplete.

"In this case the masticating occlusion of the teeth permitted the inferior incisors to strike the gums considerably posterior to the superior incisors, making it necessary to lengthen the bite of the posterior teeth and shorten the anterior. This was accomplished by a plate covering the roof of the mouth, which received the bite of the anterior inferior teeth, and by temporary crowns upon the first inferior molars. A small but very flexible German silver wire, with the ends resting in tubes in the buccal sides of the crowns, was sprung down under hooks on the sides of the bicuspids and then up over similar hooks attached to the incisors near their occluding ends. This raised the bicuspids and tended to force the incisors further into their sockets.

"A simple traction bar encircled the upper teeth with anchorage

tubes and screws on the molars. At the same time a rubber piece was fitted to the anterior superior teeth with occipital pressure, which forced them and the alveolus up and back. I soon found that this apparatus forced the crowns of the teeth back only, with an apparent tipping of the roots forward, increasing the facial prominence at the base of the nose, since which time the contouring apparatus has been worn, with all the force directed to the posterior movement of the roots alone. The case now promises a perfect result, as may be seen by the models. (Figs. 280 and 281.)"

CHAPTER XXX.

ARTIFICIAL CROWNS.

Introductory Remarks.—Though the proper construction of a modern collar crown or bridge denture requires much scientific information, unusual skill, and sound judgment, a great portion of the work entailed is necessarily done in the laboratory. It should, therefore, have a place in every work embracing the subject of dental prosthesis; it demands, in fact, a distinctive place, as it is one of the most important and exacting branches of dental practice.

As Dr. George Evans has well said, modern crown- and bridge-work, properly understood and properly performed, takes high rank in dental art, and offers wide scope for versatility of talent and inventive genius. The varied and complicated cases presented for treatment frequently suggest to the expert novel contrivances and methods of construction and application. Successful practice of crown- and bridge-work depends upon a thorough mastery of the underlying principles and expertness in the processes involved, governed by sound judgment and perfect candor. When practised by dentists possessing the requisite attainments and governed by correct ethical principles, it gives results which are gradually establishing its value, removing erroneous impressions, and insuring a wide professional and public endorsement.

There are, however, limits to the utilization of these means of support. There are many roots wholly unsuitable for the purpose. The operation may be said to be valuable in proportion as the artificially crowned root can be made comfortable, serviceable, and durable. A pulpless root that is extensively disintegrated, or that is greatly denuded from excessive absorption of the surrounding alveolus, or very loose in consequence of extended destruction of the investing membranes, cannot, in any sufficient degree, meet these requirements. Between these extreme conditions on the one hand, and those associated with partially crownless roots with the

pulp intact, the investing membranes free from disease, the cervical portions of the bony structure unimpaired by decay, and a firm attachment to the socket, conditions representing, on the other hand, an opposite extreme, there are graduations of normal and abnormal states, which, while they may not exclude the operation, must in some degree impair its value. Any estimate of the absolute value of this method of substitution that excludes a recognition of this fundamental truth is a false and unwarranted one, and there can be no rational prognostication in these cases that does not admit this truth as an essential element in forecasting results.

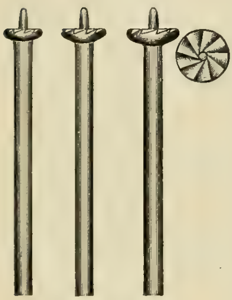
Not only will results be modified by conditions immediately associated with the root to be operated on, but also, to some extent, by the general health of the mouth. Any abnormal states of either the hard or soft tissues, or the presence of foreign deposits, will act as predisposing causes in the development of unfavorable conditions whenever the root operated on has, previous to curative treatment, been morbidly affected, and especially if such diseased conditions have been somewhat virulent and of long standing. It is best, therefore, in all cases to inspect the mouth carefully before attaching the crown, and if any of the remaining teeth are found carious or incrusted with tartar, or the mucous membrane and gums are inflamed or otherwise diseased, appropriate treatment should be directed to the correction of such abnormal conditions as may be present.

In the less favorable class of cases, or where the root has been previously diseased, though subsequently restored to a healthy condition, any diathesis or constitutional tendency predisposing to inflammation or suppuration may become a factor in the development of unfavorable results. Whenever this predisposition exists in any marked degree, the operation should be performed in the most careful manner, avoiding, as far as possible, all sources of irritation in the use of stones, saws, drills, and in tapping and malleting, and especially in the use of excising forceps for the removal of any remaining portions of the crown. Should any tenderness or loosening of the root supervene after its necessary preparation, and before setting the crown, it will be prudent to defer the completion of the operation until there is a subsidence of the morbid conditions, for if, by reason of such irritation or in-

flammation, suppuration should be reëstablished, it may be necessary to free the pulp canal and renew treatment through the apical foramen.

The success of the operation may also be greatly impaired by careless, hurried, and injudicious manipulation; as where the remaining portions of the natural crowns of the tooth are violently removed with excising forceps, by the unskilful use of instruments in dressing the root, by drills in enlarging the central cavity, by undue or misapplied force in the final adjustment of the artificial crown, or, finally, by a faulty position of the tooth of replacement, by which the root is subjected to injurious strain, either by lateral pressure or premature closure against those of the opposite jaw. By the operation of either or all of these causes, disease of a more or less intractable character may be induced which will impair the usefulness of the artificial organ and subject the patient to much annoyance.

Fig. 284.



Preparation of the Root.—In the process of preparing the root for the attachment of an artificial tooth, all remaining portions of the natural crown should first be removed with suitable instruments. If the cervical portion of the tooth is comparatively sound and unbroken, this may be most expeditiously accomplished, and with less risk of injury to the root, by cutting two parallel grooves, opposite each other, on the labial and palatal surfaces, with a small circular saw, or a hard rubber or rubber and corundum disc. These grooves should be cut through the enamel deep into the dentine. Then, with the excising forceps, the cutting edges of which are placed in the grooves, the crown is readily severed from the root.

After the use of the disc and excising forceps, any remaining portions projecting beyond the free margins of the gum should be removed, and proper shape given to the end of the root. A flat-edged corundum stone or what are known as the Ottolengui root facers (Fig. 284) are the best for the purpose, and when in use the stones should be kept constantly wet and free from clogging particles of tooth substance. The end of the root should be dressed down, anteriorly, a little below the free margin of the gum, care

being taken not to cause unnecessary laceration; in this way the artificial crown, when adjusted to the root, will unite so intimately with the gum in front, in ordinary cases, as to render exposure unnecessary. The surface of the root prepared in this manner will present a concavity corresponding with the festoon of the gum.

If a living pulp remains in the root, it will not ordinarily be practicable—unless there is partial obliteration and consequent recession of the pulp cavity as the result of ossific deposits—either to cut off the tooth on a line with the gum, or even transversely, or to dress the root even with the gum, without inflicting insufferable pain. It will be necessary, therefore, under such circumstances, either to devitalize and extirpate the pulp through the carious opening in the crown before the latter is removed, or, if not exposed by excising the tooth, through an opening into the pulp, made with a drill revolved by the dental engine, after excision.

Devitalization of the Pulp.—There are several ways of extirpating a dental pulp. One of the older and still not uncommon methods of operating consists, first, in devitalizing it with arsenious acid and then removing it with a broach. Another method practiced by some is to thoroughly expose the pulp, apply cocain, and then extract the pulp with a broach.

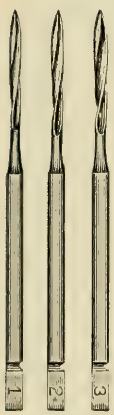
Excision of Crown and Instantaneous Extirpation of the Pulp.—A somewhat heroic method, though one with which some operators have much satisfaction, by which a living pulp may be quickly and successfully removed, with comparatively little pain, consists in cutting the labial and palatal grooves as has been directed, making them as deep as possible, without inflicting too much pain; then, with the excising forceps, the cutting edges of which are inserted in these grooves, the crown is quickly severed from the root. This usually leaves the pulp fully exposed and paralyzed, when a piece of orange wood—previously cut and shaped to about the size of the canal, not larger, and the point saturated with carbolic acid—is carefully placed against the exposed point of the pulp and quickly driven, with one light blow from the mallet, into the pulp canal. When the wood is withdrawn, the pulp often adheres to it; if not, it may be quickly and painlessly removed with a broach. In this operation the immediate paralysis induced renders it comparatively painless. Still another method,

and a very satisfactory one, is to remove the pulp while the patient is under the influence of a general anesthetic.

Preparation of the Pulp Canal.—After the removal of the pulp the apical foramen should be thoroughly closed by any method usually employed in root filling. A neglect of this important measure will greatly endanger the success of the operation.

The proper treatment and preparation of the root having been thus far accomplished, the canal of the latter should next be enlarged for the reception of a dowel-pin. This is effected with an ordinary fissure drill or root reamers (Fig. 285).

FIG. 285.



The natural opening in the root should be enlarged to the depth of two or more lines, according to the length of the root; and the orifice should be made large enough to admit a support of sufficient size to secure the crown firmly in position. The direction of the drill in cutting should follow closely that of the natural canal in the root, since but a slight deviation in this respect may endanger the integrity of the latter by too great a thinning, or actual perforation, of its walls. The face of the root should then be given a suitable shape for the reception of the form of crown to be attached, the methods of fitting and inserting which will now be considered, the simple or all porcelain system being first taken up.

Porcelain Crowns.—The system of using all porcelain crowns has a number of advantages, and at the same time there are strong reasons, we think, for using another system—known as the ferrule or collar crown—in all favorable cases.

The porcelain crown is especially useful where an inexpensive and quickly adjusted crown is necessary; or where some pathological condition would seem to limit the probable permanency of an operation, or, again, where a temporary crown is desired to serve, as is sometimes necessary, until the patient or operator can make suitable engagements for more permanent work.

The objections made to the use of this class of crowns for permanent work are that the pin or post upon which almost the entire support of the crown is thrown acts as a lever in the root canal,

and sooner or later many of the weaker roots are fractured, thus ending their usefulness as a support; and again, the pin or post, entering, as it does, deeply into the body of the porcelain, weakens it at this point, and not infrequently do patients return with the crowns fractured through the center from the force of mastication. Then, again, when the crowns are set with amalgam, which is the practice of many, the discoloration at the line of union with the root, if subsequently exposed, is very objectionable.

The all-porcelain crowns may be divided into two classes: First, those having one end of the pin or post baked in the porcelain when the crown is made, such as the Logan, Brown, and new Richmond; second, those attached to the root by a pin, post, or screw, one end of which is first cemented in the root and the other afterward to the crown. Of this class we have the Bonwill, How, Gates, Foster, and Howland.

After deciding upon the form of crown to be used, one should be selected to correspond as nearly as possible in size and general configuration with its fellow on the opposite side, and to harmonize in color with those immediately adjoining. The manner of preparing and adjusting each of the crowns named will be taken up in the order given.

The Logan Crown.—The Logan crown, invented by Dr. M. L. Logan, is probably of all these the one most extensively used. The method of adjusting and mounting is given in all its details in the following article by Dr. W. S. How:

"Fig. 290 shows a superior right central root, an end appearance of the same, and a Logan crown, front view. Fig. 185 exhibits, at a right angle to the plane of the first figure, the same root, its end, and the Logan crown, side view. In both figures the root canal is supposed to have been first drilled to a gaged depth with an engine twist-drill, No. 154, and then enlarged by means of a fissure-bur, No. 70, to the tapering form shown; the walls being subsequently grooved with an oval bur, No. 90. The enlarged section (Fig. 292) shows the crown adjusted on the root by means of cement or gutta-percha, which surrounds the post and fills all the spaces in the root and crown. Fig. 293 shows the completed crown. Fig. 294 exhibits a bifurcated bicuspid root, its end appearance, and a Logan crown adjusted to the root. Fig. 295 illustrates the best manner of bending the post. Fig. 296 shows a split post,

and its adaptation to a bifurcated bicuspid root is seen in Fig. 297. Figs. 298 and 299 exhibit the mode of mounting the Logan crown

FIG. 286.

FIG. 287.

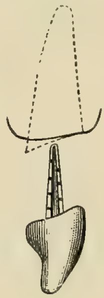


FIG. 288.

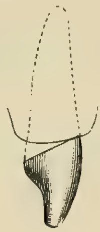


FIG. 289.

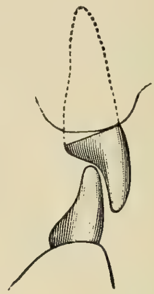


FIG. 290.

FIG. 291.

FIG. 292.

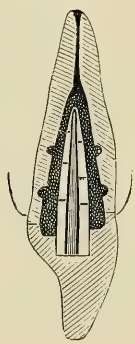


FIG. 293.

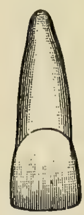


FIG. 294.

FIG. 295.

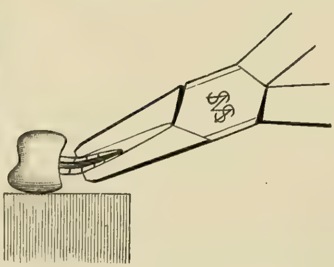


FIG. 296.

FIG. 297.

on a superior molar root, and Figs. 300 and 301 the same crown in its relation to an inferior molar root.

"The preceding figures clearly present to the mind's eye of the expert dentist the essential features of the Logan crown and the method of mounting it.

"The details are as follows: In every instance where a root is deemed ready to receive its filling, it should first be measured through its canal from the cervical opening to the apical foramen, and this may be accurately done with a gage adjustable on a delicate canal explorer. The same device serves to measure the distance from the apex to which the canal should then be filled (Fig. 286). It also gages the depth to which the drill may be carried. The proper degree of enlargement from the bottom of the drilled hole will, of course, depend on the observed size and character of the root. Every dentist should familiarize himself with generic tooth forms, so that when the length of an incisor, cuspid, or other tooth root is known, he can so nearly determine

FIG. 298.

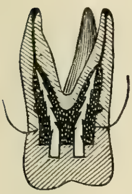


FIG. 299.

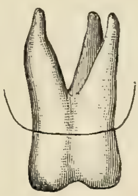


FIG. 300.

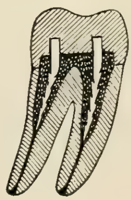
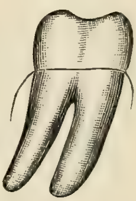


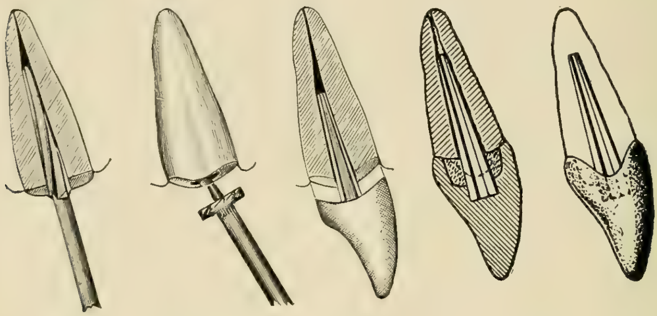
FIG. 301.



its hidden outlines as to form with precision a corresponding enlargement of the root canal, such as is shown by the several cuts. For preparing the roots, the Ottolengui root reamers and facers (see pages 476 and 478) are very desirable instruments. The reamers are made in three sizes to correspond with the Logan pins. With a root reamer of the appropriate size, the root canal is enlarged to fit the pin along its whole length, and so hold the crown firmly, *independent* of the cement. With a root facer a labial slope is given to the root end, so that the crown neck shall fit under the edge of the gum. Fig. 302 shows the method and its result, and the cross-section shows how the cement incases the pin. The suitable preparation of the bifurcated roots of some bicuspids and of all the molars is a matter involving difficulties of an unusual character and requiring good judgment. The feasibility of splitting the post of a Logan crown to adapt it to

the bifurcated root of a bicuspid is shown in Figs. 296 and 297. This example directs attention to the peculiar shape of the post, in which there is effected such a distribution of the metal that its greatest strength is in the line of the greatest stress that will in use be brought to bear on the crown, while the least metal is found at

FIG. 302.



the point of the least strain; the applied part of the post being in outline nearly correspondent to that of the root itself. The root canal is likewise conformably enlarged to receive the largest and stiffest post which the size and shape of the root will permit.

"The fitting of a Logan crown to a root may be done with a

FIG. 303.

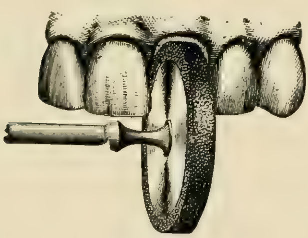
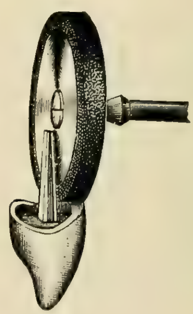


FIG. 304.



wet stump wheel in the engine hand-piece. A safe-side crown corundum wheel (Fig. 303) can be used in the same manner. It also affords the greatest facility for the slight touches required to abrade the thin cervical borders of the crown, which may by this means be done without encroachment on the post.

"By the old method of adapting pivot teeth to roots, the close fitting of the crown precluded the use of a plastic packing, because its thinness over the surface of the joint made the packing liable to break loose under the shock and strain of use. The recess in the Logan crown obviates this defect by providing a receptacle for a considerable interior body of cement that will be deep enough to be self-sustaining internally, and yet allow the peripheral portions of the root and crown to approach each other so closely that, though only a film of packing remain, it will still be strong enough to insure the persistent tightness of the joint. The annular boss, if formed of amalgam, also adds strength in some cases to the mount.

"When enough of the natural crown remains, it is well to leave standing some of the palatal portion, and cut the root under the gum margin at only the labial part, as shown by Fig. 287. The safe-side crown wheel is especially useful in such cases (Fig. 304). Thus the labial joining of the root and crown will be concealed, and the other parts of the joint will be accessible for finishing and keeping clean (Fig. 288). The Logan crown may be ground until a large part shall have been removed for adaptation to the occluding tooth or teeth without seriously impairing its strength (Fig. 289). This crown also in such cases maintains the translucency, which is one of its peculiar excellences, owing to its solid porcelain body and the absence of a metallic backing or an interior largely filled with cement or amalgam.

"The distal buccal root of the natural superior molar is nearly always too small to receive a post of any useful diameter, and therefore the Logan superior molar crown has but two posts, which, like those of the inferior molar crown, are square, and thus may be easily barbed, as may also the ribbed posts of the crowns from the anterior tooth roots. These posts are large enough in all the Logan crowns to answer in any given case, and can, of course, be easily reduced to suit thin or short roots.

"Any of the cements or amalgams may be used in fixing these crowns, but good gutta-percha, softened at a low heat and quickly wrapped around the heated crown-post, which is at once seated in the root, forms the best mounting medium, and has the great advantage of permitting a readjustment, or, if need be, the ready removal of the crown by grasping it with a pair of hot pliers or forceps, and holding it until the gutta-percha is sufficiently softened."

The Brown Crown.—This crown, invented by Dr. E. Parmley Brown, is shown in Figs. 305 to 308. Fig. 305 gives a lateral view of a porcelain crown, with an iridioplatinum pin baked in position. The pin has great strength at the neck of the tooth, where the strain is heaviest, and this strength is further increased by extending the porcelain up on to it, as shown in the accompanying illustrations.

A front view of the same crown is illustrated in Fig. 306. The dotted lines show the shape of the pin and the position which it occupies in the crown.

The pin is flattened laterally, affording a strong hold in the porcelain without bringing it too near the surface in thin teeth, while it also permits alteration of the palatal surface of the crown in a close bite without risk of weakening the body.

FIG. 305.

FIG. 306.

FIG. 307.

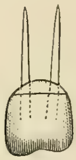


FIG. 308.

Fig. 307 is a view of the bicuspid crown, in which two pins are provided, one for each root of two-rooted bicuspids.

Fig. 308 is a view of the same crown with the two pins pressed together, forming a single pin of great strength for a single-rooted bicuspid.

The double pin in the bicuspids prevents the gradual loosening of the crown by the rotary movement of the jaws in mastication, which, acting on the two cusps, exerts such leverage as to sometimes turn and break down ordinary crowns where only one pin is used.

The roots are ground concave, to fit the crowns, with corundum points or a Willard countersink bur, and close joints are made well under the gum, the pins being set with oxyphosphate cement. The canal should be enlarged just enough to admit the pin, which should fit snugly throughout its entire length, the better to distribute the leverage exerted by the crown, and thus directly to increase the strength of the attachment.

The New Richmond Crown.—Dr. George Evans, in his treatise on "Crown and Bridge Work," describes the new Richmond crown as follows: "To illustrate and describe the method of mounting this crown, a superior left central incisor root will serve as a typical case, and its projecting end is to be shaped as seen in Figs. 309 and 310. This can be rapidly done with a narrow, safe-

FIG. 309.

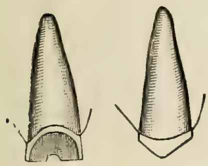


FIG. 310.

FIG. 311.

sided flat or square file, the angles of the slopes being such that the gum on the labial and palatal aspects will not interfere with nor be disturbed by this preliminary work, as the root end is not, in this operation, to be cut quite down to the gum. An Ottolengui root reamer No. 2 is then employed to bore out the root to receive the crown-post, which is of the same size and shape as the Logan crown-post for a central incisor.

FIG. 312.

FIG. 313.

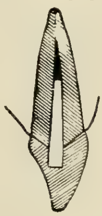


FIG. 314.

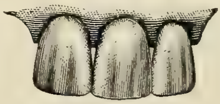


FIG. 315.

"The sectional view (Fig. 311) shows the relation of the reamer to the root. The new Richmond crown (Fig. 312) is then tried on the root (Fig. 313), and its position relative to the adjacent and occluding teeth noted. If the cutting edge of the crown is to be brought out for alignment with its neighbors, the root can be drilled a little deeper, and the reamer pressed outward as it revolves,

to cut the labial wall of the cavity. The palatal root slope must then be filed to make the V correspond to the changed inclination of the crown.

"Thus, by alternate trial and reaming and filing, the crown may be fitted to the root and adjusted in its relations until the post has a close, solid bearing against the labial and palatal walls of the enlarged pulp chamber, and the crown slopes are separated from the root slopes by the thickness of a sheet of heavy writing-paper. This space can be accurately gaged, and the root slopes conformed to the crown slopes by warming the crown and putting on its slopes a little gutta-percha, so that an impression of the root end may be taken, and the root slopes dressed with a file until the film of gutta-percha proves to be of equal thinness on both slopes.

"To permanently attach the crown, Dr. Richmond usually takes

Fig. 316.

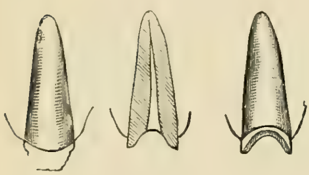


Fig. 317.

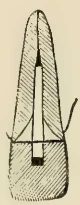
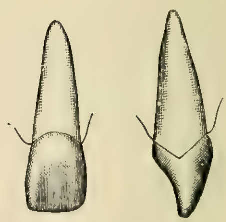


Fig. 318.



a thin, perforated disc of gutta-percha, pushes the post through it, warms the crown, presses it into place, and when cooled removes it, and with a sharp knife trims away the gutta-percha close to the crown neck. He then warms the crown, puts a very little oxyphosphate cement on the post, and presses the crown home. Fig. 314 shows the completed crown."

The obvious advantages of the device are the readiness with which the slopes of the root end may be shaped with a file; the facility with which these slopes may be given any angle to set the crown out or in at the base, or at the cutting edge, or to give it a twist on its axis; the certainty that, once adjusted, the final setting will exactly reproduce the adjustment; the assurance that in use the crown will not be turned on its axis, a most common cause of the loosening of artificial crowns; the firmness of its resistance to outward thrust in the act of biting. This is made apparent by

Fig. 315, wherein it will be seen that in an outward movement the crown B would rock upon A as a pivot. The dotted line D shows how the crown slope is resisted by the root slope, which extends so far toward the incisive edge that a much firmer support is given to the crown than if the resistance should be, as it usually is, on the line of the gingival margin C.

For roots that have become wasted below the gum surface it is not suitable, except in such cases as are decayed under the labial or palatal gum margin only, but have yet projecting the approximal portions of the crown (Fig. 316).

The sectional view (Fig. 317), and the perspective plan views (Fig. 318) illustrate the manner of mounting these crowns on this class of roots. The finished crown appears as in Fig. 318.

The cases for which this crown seems specially adapted are such as have some considerable portion of the natural crown remaining.

The Bonwill Crown.—This was one of the first crowns introduced in improved porcelain crown-work. The process of its adjustment and insertion is explained in a lengthy article by its inventor, Dr. W. G. A. Bonwill, from which the following is presented:

"These all-porcelain crowns have three distinctive features: A concave or countersunk base; a triangular opening from the base to a point at or near the cutting edge of the incisors, the base presenting to the labial surface (at its upper portion this groove is enlarged); a peripheral margin or border resting perfectly flat on the root, the concavity of the base on the palatal side being at a much more acute angle than on the approximal sides. An anchorage is made in the incisors by a depression or undercut between the labial and palatal surfaces, opening on the latter. In the bicuspids and molars the retaining pits are nearer the grinding surface.

"The concave base of the crown prevents the amalgam from escaping under the heavy pressure exerted to force it into position, and in impacting the amalgam and expressing the mercury. It allows of a dense body of material around the metallic pin, giving the equivalent of a pin the whole diameter of the base of the crown. It leaves no joint, the crown and root being continuous. The amalgam is so thoroughly hardened at once by impaction in

the double concave of crown and root as to make a very firm operation. It prevents any possibility of the crown's twisting upon the pin and root. In the event of fracture of the crown, the convex surface of the amalgam on the root makes the substitution of a new crown an easy operation. It enables the operator to fit the crown in much less time; it allows a proper position to be given to the pin, with less danger of fracture therefrom; it permits of a larger quantity of amalgam in the crown, and is capable of bearing greater strain; it makes the permanent success of the operation

FIG. 319.

FIG. 320.

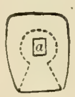


FIG. 321.

FIG. 322.

FIG. 323.

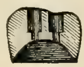


FIG. 324.

FIG. 325.

"Fig. 319.—Sectional view of an incisor crown from mesial side, showing the undercut at the point opening on palatal surface, the conical base, and the opening of the same to the retaining grooves, with the exact relations.

"Fig. 320.—Palatal view of same tooth; *a* is the external opening for egress of alloy and for packing around the pin. The dotted lines show the recess or undercut on the mesial and distal sides and near the point for retaining the crown, and its relation with the conical base.

"Fig. 321.—Grinding surface view of a superior molar with the countersunk pin-holes on the buccal and palatal sides.

"Fig. 322.—Same view of an inferior molar with the pin-holes on the mesial and distal sides.

"Figs. 323 and 324.—Sectional views of a molar and a bicuspid crown, showing the countersinks and their relations with the conical base.

"Fig. 325.—Sectional view of an incisor root, showing the retaining cuts made by the wheel-bur shown in Fig. 332.

probable, from the fact that it is absolutely jointless, and secures immediate solidity, even while the amalgam is semi-plastic. These crowns are capable of resisting the force of biting or mastication, because they are supported nearly to the cutting edge or grinding surface, the triangular opening from the concave base nearly to the cutting edge allowing the pin to be imbedded in the labial face of the crown where there is the greatest amount of porcelain.

"The amalgam to be used as the medium of union must set quickly and be very hard. Thus far I have found nothing better than the alloys I have specially prepared for this line of work, and,

though they are costly, the superior results obtained by their use amply repay the cost. I use No. 1 generally. If mixed thick, it will set so quickly that the operator must work rapidly to prevent its being wasted. In incisor cases I use No. 3 at the gum line and make a close joint.

Fig. 326.

Fig. 327.

Fig. 328.

Fig. 329.

Fig. 330.

Fig. 331.

Fig. 332.

"Fig. 326.—End view of a canal prepared for the improved combination-metal pin.

"Fig. 327.—End view of same canal as in Fig. 326, prepared for a triangular pin, showing how much more of the mesial and distal surfaces have been cut away from it than in Fig. 326 for the improved pin.

"Fig. 328.—Sectional view of an incisor crown and root, with the improved pin in its relative position to each,* with the depressions made by wheel-bur.

"Fig. 329.—Sectional view of a superior molar, with the large angular pin in palatal root and two square pins in the buccal roots, one being shorter and not passing through the crown.

"Fig. 330.—Block of a molar and bicuspid, showing the countersunk holes for pins in the molar, and the hole in the mesial side of the second bicuspid where a pin is alloyed in and set into a decayed cavity in the distal surface of the first bicuspid, being held upon the molar roots and attached to the bicuspid by the alloy.

"Fig. 331.—Side and end view of the largest sized angular combination-metal pin with the stamped serrations.† The square pins are without serrations and double-pointed, made of the same metal and of equal thickness throughout.

"Fig. 332.—The smallest sized wheel-bur for grooving the canal for anchoring the pin and alloy.

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* The sectional views of the incisor and molar, giving the relative position of the pins in the crowns and roots, should show pins of larger size. The pins as furnished should be filed down but little. It is not absolutely necessary that so many serrations should be made in the canals by the wheel-bur for retaining the amalgam and pin as are shown in the sectional view of the root of an incisor. While no serrations are shown in the roots of the molars, it is understood that all the canals must have the serrations. The square pins in the canals need no serrations. At the point where they occupy the countersink in the crowns, make two or three very slight cuts on the edges with a sharp file. The ends can be left blunt.

† These pins are now made without serrations. When amalgam is used for securing them, they become amalgamated and firmly united.

"In preparing the canal, use first a small-sized, spear-shaped drill, carefully following the natural channel. Then follow with a larger one, taking care not to cut through the root near the apex. On the mesial and distal sides cut away but little, as there is where fractures are most liable to occur. The canal can be very tapering and yet hold the pin. There need be but very little space around the pin. By all means save all the walls of the root possible. The smallest sized wheel-bur may be used to make a thread at various points along the canal to hold the amalgam.

"If the patient exposes the gums much in speaking or smiling, the root may be cut down with the bur or corundum wheel beyond the free edge, to conceal the joint. With bicuspids and molars it is not necessary to go below the gum; a joint well made will not be observed, and the strength of the root will be preserved. If the root is decayed below the gum, after removing the softened parts fill it with alloy.

"It is not necessary that the face of the root should be flat; it may be either concave or convex, according to indications.

"It is advantageous to take an impression and bite of the root, and make a model and articulation in plaster.

"The crown to be inserted should be inspected closely, as the retaining undercut in the incisors and the depressions in the bicuspids and molars may not be well defined. If not, the crowns are liable to work loose. If the base has been ground off in fitting, the edges should be beveled again to a fine margin with a corundum point. The crown should be fitted to the root in the mouth, not to the plaster cast. The articulation should be clear, to avoid displacement. The pin should be as large as the previously prepared canal will admit. The pin must in every case be fitted, and in fitting it file only on the plain sides. Leave the end sharp, to offer the least resistance in passing through the amalgam. The end of the pin to be passed into the crown needs very little alteration. The crown, being open on the palatal surface of the incisors, permits a blunt-pointed pin to go up to its place. The middle of the pin should not be interfered with if it can be avoided. It is well to cut the pin a little short for incisors, as it may not get pushed entirely up in the root through the amalgam. Small square pins are used in the bifurcated roots of bicuspids and in the buccal roots of molars. They can be sharpened at both ends, but the

outer end will not require so much sharpening. The palatal roots of molars will generally take one of the largest thick pins, with one square pin in the largest and most accessible buccal root. Each canal should have a pin, if the canal can be reached and properly prepared to receive it, even though the pin has to be so short as not to pass through the hole in the crown. If it enters the countersunk base it will support the root. The lower molars will require two of the largest sized pins. As the support of the root is dependent upon the size of the pin and the depth to which it is inserted, single-rooted teeth should have the very largest thick pin. If the root is thin on the mesial and distal sides, the thin, angular pin is to be preferred. Ordinarily, these large pins do not have to be bent. If necessary, it had better be done with a hammer and before the mercury touches them. The pin should have free movement in both root and crown. Should it be discovered that the pin is too long after it has been packed in the root, it can be cut off with sharp forceps, pressing them up against the pin to prevent displacement. The pin can be sharpened subsequently with the corundum wheel.

"To insure an amalgamation of the pin with the filling, brighten the surface of the former before inserting.

"The roots, crown, and pins being in readiness and arranged on the table, so that no mistake may occur from getting the pin in the wrong position, and the appliances necessary for the operation being at hand, the alloy preferred should be mixed a little thinner than if intended for a filling, especially where the root has a long canal. The shorter the canal, the thicker the amalgam may be mixed. Mix only enough at one time for one root. Put enough amalgam in the canal to nearly fill it, but do not pack it; force into it a steel pin made for the purpose, of about the same size as the pin, to make way for the easier insertion of the latter. Then grasp the pin with suitable forceps, and carefully but steadily press it up to its destination. If you cannot succeed in doing so, remove it, and again use the steel pin. When in place, use an instrument with a point small enough to pass between the pin and the root, and pack by tamping the amalgam around it. A piece of bibulous paper placed over the point of the instrument will assist materially in carrying the amalgam before it. Before the amalgam has become too hard, replace the crown to determine that the pin is in

proper position; if not, it can be crowded to one side or the other with the tamping tool. Should the pin be found to be rather long, it can be ground off with the corundum wheel, holding it meanwhile with the forceps. No attempt should be made to bend the pin after it has been amalgamated, for fear of breaking it. If any amalgam has been left, and it is still plastic, it may be packed around the pin at the base of the root, using the bibulous paper as before directed. If not, mix again to complete the operation. Bank up the amalgam on the root high enough to fill the base of the crown. The crown should now be tried on, and forced home with an adjuster adapted to the case, removing the surplus amalgam if too much, or adding if not enough. Remove and dry the crown; and fill up simply the undercut cavity near the cutting edge if an incisor, or the depressions in the crowns of bicuspids or molars, allowing a very little to extend into the cervical base. Now force it home with the adjuster. It requires considerable force to set one of these crowns according to directions—a force which cannot be applied with a mallet without danger of loosening or displacing the crown. Steady pressure with slight rotation will carry the crown into place, if the amalgam is not too hard or there is not too much of it. I would advise you not to attempt to set a crown without an adjuster or its equivalent. Free mercury will be squeezed out on the palatal surface, which should be wiped off. Now hold the crown in place with the fingers, with the bibulous paper under the tamping instrument, and consolidate the amalgam around the point of the pin in the crown, absorbing any free mercury which appears there. The excess of alloy at the joint must now be removed, care being taken to press the crown up while this is being done. The amalgam packed around the pin in the crown on the palatal side should be as stiff as may be to work readily. It is well to leave over some of the first mixing for holding the pin, and this will be about right for consolidating about this point.

"If, in a bicuspid or molar crown, the pin should come so far through as to interfere with articulation, it may be ground off with the corundum wheel while the crown is firmly held.

"The case can now be dismissed, with directions for the patient to return the next day, in order to make sure that the articulation is correct and to dress off the joint between the crown and root, which may be done with a small, round-headed bur.

"There are some cases in which the root cannot be filled with anything; if in a molar, the pulp-chamber can be relied upon to hold a headed pin or pins. When a tap-hole is required in the root it can be made low down and at an acute angle, and the amalgam packed around the root canal above the tap.

"Should an artificial crown be broken, another can easily be substituted by burring off any excess of amalgam, and using fresh amalgam, mixed thin, to allow of ready adjustment.

"Two crowns can be inserted on the root of one large molar with the assistance of the decayed approximal surface of an adjacent tooth (see Fig. 330)."

The Porcelain Dovetail Tooth Crown.—These crowns are designed for the roots of bicuspids and molars only, and the process of mounting them may be very briefly described:

"Fig. 333 shows the roots of an inferior molar after the apical

FIG. 333.

FIG. 334.

FIG. 335.

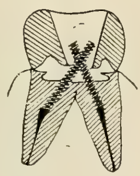
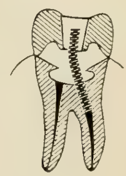


FIG. 336.

FIG. 337.

FIG. 338.



portions have been filled, the neck recessed, the canals drilled and tapped, and two How screw-posts firmly fixed therein, the ends of the posts having been pinched toward each other by means of a pair of pliers, so that they will go through the central opening in the crown (Fig. 334). This opening is of a dovetail form, as shown in cross-section by Fig. 335, where the crown is seen in place over the posts on the root. It is thus made obvious that the crown may be easily put on and off the root in the process of fitting the crown-neck to the root-neck, and also that, for occlusion, the crown may be ground low on any or all sides without destroying the dovetail function of the central cavity. When the fitting is completed, and the crown cut so short as to be $\frac{1}{32}$ of an inch distant from the occluding tooth, amalgam is packed into the neck recess, around the posts, and thinly over the cervical margin of the root, the crown put in place, and, with thumb pressure, firmly seated. Then test the occlusion, and complete the opera-

tion by packing amalgam into the crown opening, which will permit the forcing of the amalgam in all directions, to insure a firm base for the crown and its secure dovetail attachment to the posts, as shown by Fig. 335.

"The bicuspid crown (Figs. 336 and 337) is similarly mounted, as may be seen in Fig. 338, cross-section; the same crown and root being shown in contour by Fig. 339. In some instances this bicuspid crown may, like the Foster crown, be secured by a headed screw, as shown in Fig. 340. The root having been drilled and tapped and recessed, and the crown properly fitted and articulated, the screw is put through the crown, amalgam packed in the crown groove and around the screw, which is then inserted in the root, and the crown pressed hard into its place. The screw is then turned into the position shown in Fig. 340, thus compressing the amalgam or cement in both recess and groove, after which the

FIG. 339.

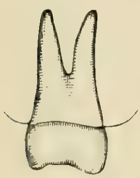


FIG. 340.

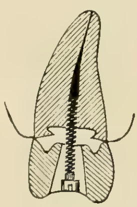


FIG. 341.

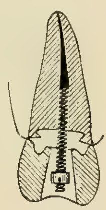
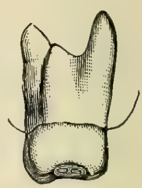


FIG. 342.



screw-head may be covered with amalgam, cement, or gold, as desired.

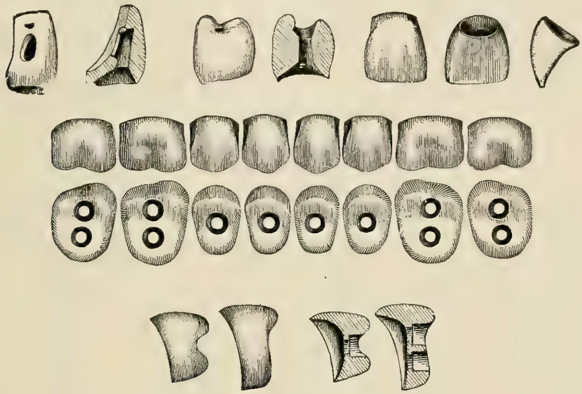
"As a preferable mode, however, the screw-post may first be fixed in the root, the crown adjusted over the post, amalgam packed on the root and around the post, the crown seated firmly, more amalgam packed in the crown cavity around the post, and then a nut screwed on the post, as shown in Fig. 341. In all the sectional cuts cement, amalgam, or gutta-percha is to be understood as filling the cavities in the conjoined roots and crowns.

"Fig. 342 shows in contour a dovetailed crown mounted on a superior molar root in the manner shown by Fig. 335. It is obvious that the crown of Fig. 335 might be ground quite down to the post ends, and yet be firmly held by the dovetail sides of the central cavity."

The Gates Crown.—The Gates crown is quite similar to the

Bonwill crown. It is usually attached to the root, however, by a metallic screw manufactured for the purpose, such as is illustrated

Fig. 343.



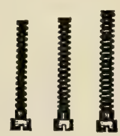
in Fig. 344, instead of the Bonwill pin. The screw is first inserted in the root and the amalgam packed around it. In nearly all roots, at a reasonable distance up the canal, a suitable place for fastening the end of the screw can be found. Too much force must not be applied in its insertion, as a root is easily split. In bicuspid and molar crowns nuts are used on the screws, which fit slots in the grinding surface of the porcelain. They are screwed into the amalgam or cement, and covered with it in the process of cementation of the crown.

Fig. 344.

The Foster Crown.—The Foster crown also resembles the Bonwill, but has less concavity at the base. The crown is attached to the root by a headed screw (Fig. 346) or a screw with a nut, instead of the Bonwill pin.

Fig. 345.

Fig. 346.



The How screws and instruments (Fig. 347) are best adapted for use with these crowns.

The Howland Crown.—This crown is attached like the How dovetail crown, with screws that are first inserted in the root. It is used mostly on bicuspid and molar roots, and consists of a hollow porcelain crown, with a cavity in the crown sufficiently large to admit the screws or pins (Fig. 348) and, when necessary, a small portion of the root.

The method of setting this crown, as described by Dr. S. E. Howland, the inventor, is to trim the root even with the gum, with a stump file (a corundum stone or the Ottolengui root-facer on the dental engine, however, is more suitable); fit the crown to the root; enlarge the root canal so that a threaded pin of proper size will pass in easily, partially fill the canal with zinc phosphate, and press the pin to its place with pliers. The crown should then be filled with zinc phosphate and pressed to its place, care being taken to hold it in position until the cement sets (Fig. 349). If any operator distrust the ability of zinc phosphate to make a perfect joint, a small quantity of silver amalgam or gutta-percha can be used to advantage.

Fig. 347.

Fig. 348.

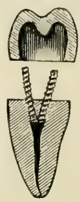


Fig. 349.

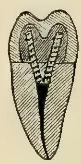
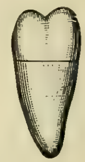


Fig. 350.



The mode of fastening is strong and simple, and when set, if a good joint has been made, none of the phosphate or other setting material is visible. It is a perfect imitation of the natural tooth (Fig. 350).

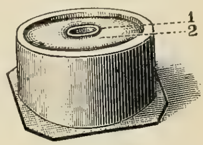
PORCELAIN CROWNS WITH GOLD COLLAR ATTACHMENT.

A very good combination for some cases is to use a gold collar, either seamless or soldered, in combination with any of the porcelain crowns.

The root having been properly prepared to receive a collar, it is adjusted and adapted the same as for the Richmond crown (see p. 503). The porcelain crown, the base of which should be fully as large as the end of the root, is then ground even with the cervical walls, and fitted into the collar, which should be trimmed and burnished to the form of the crown. Dr. Townsend's fusible

metal die, used in the following manner, facilitates the application of a collar to a Logan crown (Fig. 351): Prepare the root canal to receive the pin. Grind a suitable Logan crown to fit, and articulate it. Construct a band of No. 30 gold (for instructions see p. 505), which should be wide enough to project beyond the end of the root $\frac{3}{32}$ of an inch. Cut a wooden peg about an inch long and taper one end of it to the general size and shape of the pin in the Logan crown. Place the band on the root, insert the peg in the canal, and fill up the band with Melotte's moldine, pressing it closely about the peg. Remove all together, and, holding the die over the flame of an alcohol lamp to melt the fusible metal, place them altogether on the die, with the pin in the socket, and press down until the moldine rests on the surface of the molten metal. Then carefully chill the tooth; in cooling, the fusible metal takes a firm hold on the lower edge of the gold band, holding it securely in place during the remainder of the operation. Now remove the peg and the moldine, and with a wooden mallet drive the Logan crown into the band *until the porcelain rests upon the fusible metal.* Burnish the band smoothly about the crown. When it is perfectly adjusted to the porcelain, melt the fusible metal to release the band and crown.

Fig. 351.



1. Socket. 2. Fusible Metal.

Fig. 352.

Fig. 353.

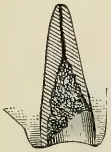


Fig. 354.

Fig. 355.

If the work has been carefully done, the crown will then be ready to be adjusted in the mouth.

Enough of the labial portion of the band should be trimmed away to prevent too conspicuous exposure of the gold (Fig. 352).

This collar combination is available in very difficult cases, as, for

instance, when a root is decayed upon one side beneath the gum margin, as seen in Fig. 353.

This operation, when completed, would appear in vertical section like Fig. 354, and a view in perspective would resemble Fig. 355.

Dr. E. C. Kirk's method of combining the porcelain crowns with a band or collar, is shown in Figs. 356 and 357. Here the Foster crown is employed. First a collar is made and fitted to the root; it is cut narrow on the labial side, and left wide on the lingual, so that it shall extend nearly to the cusp of the crown when finished (Fig. 357). The seamless gold collars are well suited for application to this style of crown.

The crown selected should have a somewhat greater circumference at the base than the collar, so that when ground down some-

Fig. 356.

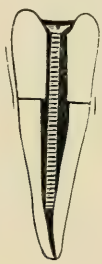


Fig. 357.

what conically on its lingual and approximal surfaces it can be tightly adjusted to the collar, which would be impossible if a crown smaller than the collar is used. The screw is fitted so that it will hold the crown in proper relations with the root. It is then removed with the crown, the parts dried, and the root canal filled with a slow-setting oxyphosphate cement. The crown is then pressed home, the surplus cement flowing through the opening in the porcelain and filling up any interstices around or between the band, the root, and the crown. The screw is then forced to position, and, when the cement is set perfectly hard, the head of the screw or the nut on it is notched to form a retaining pit, and the countersink of the crown filled with gold.

Dr. C. S. W. Baldwin's method is to cap the root and attach a Logan crown in the following manner:

First, the root is shaped for the proper adaptation of the band.

The band and cap are then made as directed for the Richmond crown on page 503. The edges are then trimmed to fit the festoon of the gum; a hole drilled from the inner side for the pin, leaving the raggedness made by drilling to catch in the cement. Place the cap on the root and fit the porcelain crown accurately to it in the desired occlusion and position. Fig. 358 shows a root, cap, and a Logan crown. A crown having the H-shaped pin, but square on the edge, like some of the early patterns of Logan or Bonwill crowns, would reduce the time of setting and give best results. Having polished the edges of the cap, the crown may be conveniently adjusted as follows: Place oxyphosphate cement in the countersunk portion of the porcelain, and in the canal only

FIG. 358.

FIG. 359.

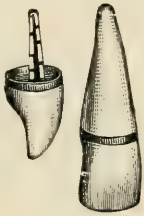


FIG. 360.

FIG. 361.

enough cement, of creamy consistency, to fill it, as the pressure required to force out the surplus under the edges of the cap destroys many nicely adjusted crowns, leaving bulging irritants instead of smooth supports. If proper attention has been given to fitting the crown and root, all will come nicely to place; but in some cases of difficult adjustment it may be necessary to cement the crown to the cap before fastening the pin in the root (Fig. 359).

In most cases the gold band will be invisible and below the free margin of the gum. There are instances, where the anterior teeth are prominent, in which it will be necessary to cut away the top of the cap in front, allowing the porcelain to come directly in contact with the root, the band going deeper than in ordinary cases, which prevents the appearance of gold (Fig. 360).

Dr. Bonwill's plan is to cap the tooth with a platinum or gold cap having a slot, into which the pin passes as it is slipped on the root (Fig. 361). The crown is then secured with amalgam in the usual way.

Dr. Sidney S. Stowell's method is as follows: Make a closed cap, using the combination crown metal, and place it upon the root. The cap is then perforated and the root reamed for the dowels. The bite in wax is now taken, after which the cap is burnished into the countersunk end of the root (Fig. 363). The dowels of platinum and iridium wire are now set in their places, being allowed to project ¼ of an inch so that they may adhere to the impression of plaster which is then taken. From this a cast is made of investing material; calcined marble-dust and plaster is preferable, though fine molding sand will do. The dowels are now cut off even with the top of the cap (Fig. 364).

Fig. 362.


Fig. 363.


Fig. 364.


Fig. 365.

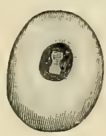

Fig. 366.


Fig. 367.


Fig. 368.


Fig. 369.


The tooth to be used may be a Logan or Brown crown, or a common countersunk tooth. As the case in question is a bicuspid, we have selected for it a Logan crown. First, cut off the pin, and then the tooth is ground into position on the cap; grinding the stump of the pin and porcelain alike evenly and smoothly. The stump of the pin is now ground with a small wheel below the surface of the porcelain (Fig. 365). The tooth is invested (Fig. 366), and pure gold fused on to the platinum pin, and while in a fluid state it is, with a wax spatula, spatted down flat (Fig. 367). The gold is filed or ground down even with the porcelain, and at the palatal border the tooth is ground to bevel back until the gold is reached (Fig. 368. The tooth is now fastened in place on the cap with wax cement (Fig. 369), the cast cut away, and the case invested in asbestos and plaster (Fig. 370). This is used because of the fiber of the asbestos, which prevents the separation of the crown and cap. The wax is removed with boiling water, or is burned out, the

case thoroughly heated up, then a small clipping of thin platinum plate is crowded into the opening (see Fig. 370) caused by the grinding of the bevel on the crown. The clipping of platinum serves as a lead for the solder, which follows it down into the countersunk cap, around the ends of the dowels, and finally attaches itself to the pure gold already firmly attached to the stump of the platinum pin. When cool the case is removed from the investment, dressed and polished (Fig. 371). A sectional view of a like tooth (Fig. 372) shows the organization in detail.

Fig. 373 shows a central incisor root on which a Logan crown is used after this method. Fig. 374 shows how delicately an operation of this kind may be performed upon an inferior central incisor, by the use of the countersunk tooth crown, which is shown as it appears before gold has been melted in its cup around the pin; when the cup has been filled with gold, and after the crown has

FIG. 370.

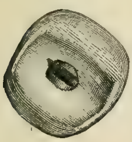


FIG. 371.

FIG. 372.

FIG. 373.

FIG. 374.

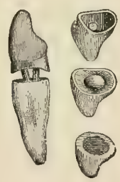
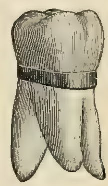


FIG. 375.



been ground and beveled. A countersunk molar crown is shown as likewise mounted on the roots of a superior left second molar (Fig. 375).

The cuts are made from photographs of prepared specimens, the natural roots of which vary in the several figures; and in the section (Fig. 371) the continuation of the pulp canal does not appear, because obliterated in preparing the section.

The claims for this method of crown-work are as follows: The combination of an all-porcelain crown with a closed cap and dowels; the adaptation of which crown and its final attachment to the root can be made perfect.

The dowels may be set at any angle that the direction of the root canal may indicate, using one or more dowels as the case may require, and when the root has to be cut off much below the gum, and a collar cannot be placed, a platinum disc floor on the root

end is the preferable plan. The well known and easily detected plate tooth having a gold backing which renders the tooth dull in appearance is thus made obsolete, for this crown possesses the translucent appearance of the natural organ. Best of all, the glaring gold of which some so-called beautiful crowns are almost entirely composed is by this means superseded. We here refer to gold bicuspids and molars, more especially to the former; it was the unsightly appearance of these which first led us to try and improve on them.

While recognizing the unquestioned value of the closed cap and dowel, we respectfully present a supplemental method which results in a crown possessing all the merits of the former with additional embodiment of strength, beauty, and practicability.

Dr. Shulze's Method.—Another method of crowning, by using a plain rubber porcelain tooth in combination with a gold collar is that described by Dr. Wm. H. Shulze, Atchison, Kansas. The

FIG. 376.

FIG. 377.

FIG. 378.

FIG. 379.

FIG. 380.

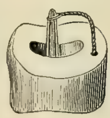


FIG. 381.

FIG. 382.

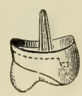
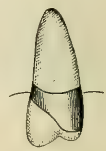


FIG. 383.



doctor says: "My mode of utilizing the plain rubber porcelain tooth for a bicuspid crown will be found to be both simple and practical. After preparing a tooth root as for an all-gold crown by fitting over the root neck a gold collar of the proper width, as in Fig. 376, remove and cut away the front of the collar (Fig. 377). Bevel the labial edge of the root so that the tooth can set well into the collar (Fig. 378). Replace the collar on the root, dry out, and place a little softened wax on the end of the root. Select a suitable plain rubber tooth, nip off the heads of the pins, grind so that it will enter the collar, adjust, and articulate, pressing the tooth against the wax. Carefully remove the collar and tooth (Fig. 379). Invest in plaster and asbestos fiber (Fig. 380). Fit a thin piece of platinum into the collar, burnishing it down on the tooth, and bending it down to the pins. If it is desired to use a post, remove and punch the platinum plate at the proper place, and solder in a post; replace within the collar, and secure with a piece of binding

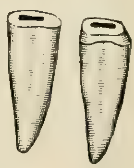
wire imbedded in the investment (Fig. 380). A little 18-carat solder will join together the collar, platinum plate, and tooth pins (Fig. 381). If there are any places where the collar does not fit the tooth closely, pack in gold-foil before soldering. If the inner cusp does not fill the collar, or it needs lengthening for occluding purposes, get the desired shape with wax when fitting the tooth. Remove the wax after investment, pack in gold-foil pellets, and add enough 20-carat solder to flow through it, and the desired addition will appear as in Fig. 382. The completed crown, mounted as usual with cement, is shown in Fig. 383.

The advantages of this method are its simplicity, ease of adaptation and articulation, the short time required to fit and make the crown, its strength, security, and natural appearance, and the convenience of using a plain rubber or saddle-back tooth.

FERRULE OR COLLAR CROWNS.

The Richmond Crown.—This crown was originally brought to the notice of the profession by Dr. C. M. Richmond, of New York. Numerous modifications have been made, however, which enhance its value. The process of constructing the improved crown is as follows:

Fig. 384.



1. The root must be trimmed down to about the gum line, except the labial portion, which should be cut nearly $\frac{1}{16}$ of an inch below the gum margin. For this purpose, corundum stones or the Ottolengui root facers are employed, as shown in the preparation of roots for the Logan crown. (See pp. 476 and 478.)

2. The ring of enamel remaining upon the root should be carefully and thoroughly removed (see Fig. 384), making the sides of the root parallel, so that the band, when applied, may *fit closely its entire width.* If this is not done, the band, even if a narrow one, instead of fitting closely will form a pocket beneath the gum margin, and will, in consequence of its irritating effect upon the surrounding tissues, cause more or less inflammation and possibly the loss of the root.

Numerous instruments have been devised for the removal of this enamel; among the most efficient are those invented by Dr. Calvin S. Case and Dr. Geo. M. Weirich. Fig. 385 illustrates Dr. Case's enamel cleavers. These are so shaped that they can be partially rotated under the margin of the gum, presenting a sharp point

toward portions of the enamel that will not easily clean off, with a

Fig. 385.

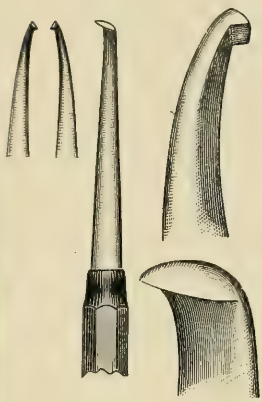
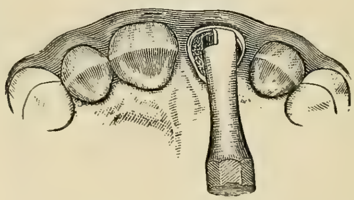


Fig. 386.



view to fracturing it as the diamond cuts glass, breaking it up into small pieces which can readily be detached and the sides straightened and smoothed by the broad blade. The peculiarities of shape are shown in the enlarged cuts.

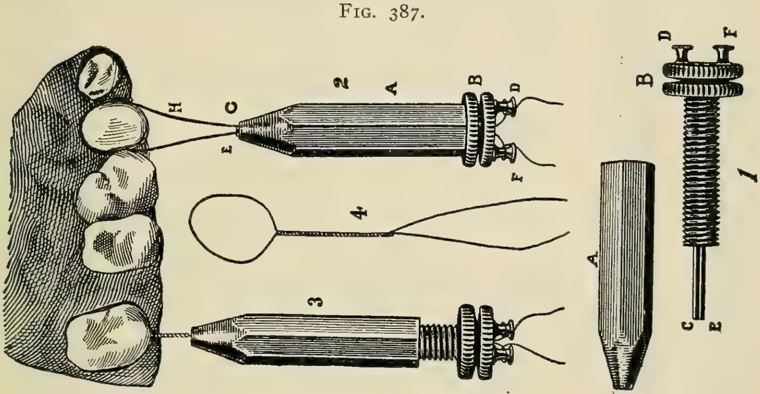
The Weirich cleaver or chisel is shown in Fig. 386. With this instrument and a few gentle blows from the mallet the enamel is readily broken up and detached. The rubber cushion in the center of the chisel takes up the blow, thus relieving the root from unnecessary shock. In the accompanying illustration the instrument is shown in place ready to receive the blow from the mallet. It is a well-known fact that with most of the appliances on sale it is difficult to properly remove the enamel from the approximal surfaces of roots, especially where they are very close. With this instrument, to be followed with the ordinary cervical wall chisel or the Chase cleavers, the root upon all sides can be readily and properly prepared for the reception of a band or collar with very little discomfort to the patient or trouble to the operator.

3. After the enamel has been thoroughly removed, an accurate measurement of the neck of the root should be secured. For this purpose Dr. A. I. F. Buxbaum, of Cincinnati, has devised an instrument known as Buxbaum's dentimeter, with which the work can be very satisfactorily per-

formed. It is illustrated in Fig. 387. It is very simple to adjust and operate, and has the advantage over other instruments of this kind, that, as you do not have to twist the entire instrument, the wire does not incline to slip off the root or lacerate the gum.

Dr. Buxbaum gives instructions for using his dentimeter as follows: "Pass one end of a soft wire through tube at C, as shown in Fig. 2 of accompanying illustration, and wrap once around knob D. Pass the other end of wire through tube at E, as shown in Fig. 2, and wrap around knob F. Place the loop H around the tooth or root. While unscrewing the screw, by holding milled nut B between the thumb and forefinger of right hand, you must make *constant traction on loop* around the tooth by gently pulling on

Fig. 387.



barrel A, held between thumb and finger of left hand; this will give a perfect twist, as shown in Fig. 3. Unfasten ends of wire from the knobs D and F and withdraw from dentimeter. The result is shown in Fig. 4."

Other and simpler instruments for taking measurements of teeth or roots have been devised, notably those by Dr. Edward C. Kirk, and Dr. Geo. M. Weirich, of Philadelphia, which are shown in Fig. 388.

4. In order to transfer this measurement accurately to the banding material, cut the wire loop in the center and spread the ends in opposite directions, as shown in Fig. 389. It is then laid on the piece of gold to be used for the band (which should be 22-carat and about 30 gage); this should be cut the *exact length of the wire,*

and about ⅛ of an inch in width, unless for special reasons it is necessary to have it wider. This small strip of gold should now be annealed over a lamp or Bunsen burner, then with round-nosed pliers it should be brought into a circular form, and with the fingers the ends should be carefully pressed by each other. This will form a slight kink in the band, so that the ends, if now gently drawn apart and let go, will spring accurately together ready for soldering.

FIG. 388.

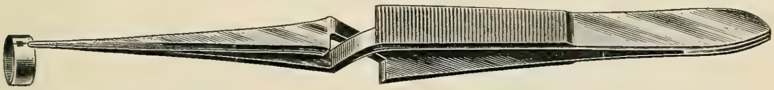
5. In soldering the band, a corner of the two edges should be grasped with the soldering pliers, the joint slightly coated with borax, and a small piece of 20-carat solder placed over it, *on the outside of the band* (see Fig. 390). It should then be held in the flame of a Bunsen burner until the solder flows, at which time it should be *instantly removed.* With a little experience and care in soldering in this way (over a Bunsen burner), it can be done more conveniently, in less time, and with much less danger of burning the band, than with the blowpipe.

FIG. 389.

6. The band is now ready to be fitted or adjusted to the root. If the end of the root is not round, as is usually the case, the sides of the band can be flattened or otherwise shaped with slight pressure from the thumb and finger or with suitable pliers. The upper border should then be trimmed to conform to the shape of the process or the line of the gum attachment; in many cases, unless the band is greatly depressed or cut out on the sides, it will be found that the gum will be detached from the sides of the root, and that the process will be reached before the root is covered high enough on the labial and palatal surfaces. Place the band thus shaped upon the root, and if the measurement and each progressive stage

have been accurately performed, it will be found to fit perfectly. Now press or drive it up carefully, until the point of attachment between the soft tissues and the root is reached (about $\frac{1}{16}$ of an inch beyond the gum margin), which is shown by the slight whitening of the gum. When this is very marked upon any side, the band should be removed and relieved by cutting it away at that point, and then readjusted. A corundum wheel is now gently passed over the labial portion of the lower edge of the band, to level it with the face of the root and to render the band invisi-

FIG. 390.



ble when the crown is finished. In doing this the wheel used should be revolved *toward the root,* to prevent irritation of the soft tissues, and at the same time it will turn the feather edge of metal over the end of the root.

7. The base-plate is more easily and quickly formed. Cut a piece of gold (34 gage) of suitable length and width, anneal, and then press it against the lower edge of the band with the fingers until it is nicely adapted; secure it in this position for soldering by three or four strands of wire, as shown in Fig. 391. Now paint the joint with borax dissolved in water, lay a small piece of 20-carat solder against the back or palatal portion of the band, *on the outside,* and hold it in the flame of a Bunsen burner until the solder flows, which will be seen to run entirely around the band, uniting it with the base-plate at every point. The surplus of the base-plate material should, with shears (see Fig. 392) and corundum stone, be trimmed off flush with the band, the two now forming a complete cap for the face and sides of the root.

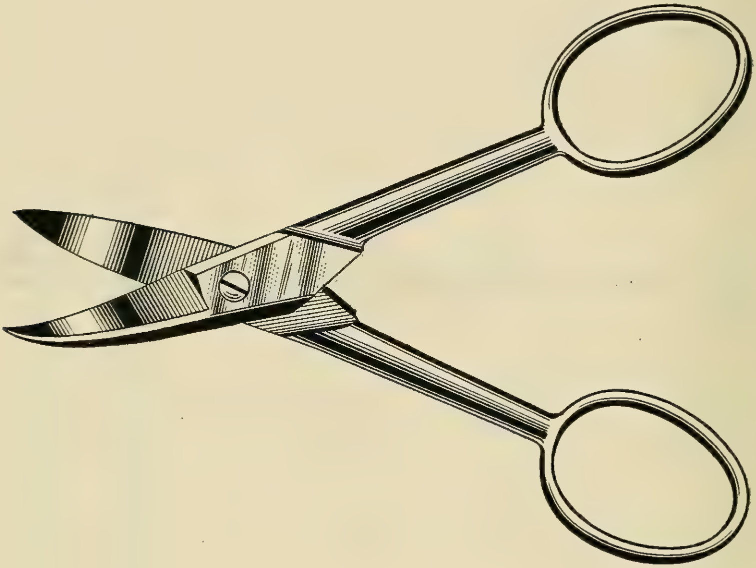
FIG. 391.

8. The next step is the preparation and adjustment of a pin through the cap into the root canal. The canal should be enlarged toward *the palatal* side of the root; this will give more room for grinding and adjusting the tooth, and at the same time secure the greatest attainable strength when the crown is completed.

The base-plate of the cap is perforated at a point directly over the opening into the canal. This may be done either with a bur

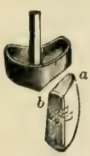
on the dental engine or with the plate punch. A pin of platinum wire, No. 16 or 17, standard gage, should now be slightly

FIG. 392.



tapered at the end and passed through the aperture, and up into the root canal. The end of the pin projecting below the cap may be marked, withdrawn, and bent at a right angle, so that it will point away from the tooth, that is, toward the palatal surface; it may then be waxed in, invested, and soldered with the tooth, or, invested and soldered at this stage, and the surplus of pin and solder brought down flush with a file or stone.

FIG. 393.



9. The cap and pin should be readjusted to the root. A plain plate tooth,* of suitable form and color, is now ground and fitted to the cap. The labio-cervical edge of the tooth (*a*, Fig. 393),

* Many writers advise using cross-pin teeth; it is self-evident, however, that in this work straight-pin teeth should be employed and the cross-pins avoided wherever possible, for the following reasons: (1) The position of the pins weakens the body of the tooth. (2) Their position makes the strain upon the tooth greater, as it gives increased leverage between the pins and the cutting edge. (3) There is more liability of cracking the teeth in soldering, on account of so much metal being brought at one point.

should be so ground that it will be flush with the edge of the band and meet the margin of the gum. It should also be ground out at the center of the base (*b*), so as to form a slight space just over the base of the pin.

The tooth is then backed with either thin platinum or gold plate (gold will give a slight yellow shade to the tooth, while platinum will give a bluish tint). The upper edge of the backing, brought down thin with a file or stone, should extend as far as possible under and between the tooth and the cap, so that the solder will more readily flow in and fill what space there may be. The incisive edge of the backing should also be brought slightly over the edge of the porcelain (though it is not so shown in the accompanying illustrations), this portion of the tooth being previously beveled with a fine corundum stone. In this, the possibility of breaking the tooth from the force of mastication is much diminished.

10. A perfect joint and the proper length and angle of the tooth having been secured, the pieces, that is, the tooth, cap, and pin, should now be thoroughly dried and then held together in the proper relationship, and secured in this position by running warm adhesive (resin) wax over the palatal portion of the tooth, attaching the backing to the cap. It should then, before the wax gets very hard, be carefully carried to position upon the root, when any correction in the position of the tooth can readily be made. Now apply a little cold water from the syringe or on a pledget of cotton; this will harden the wax, so that the crown may be removed without changing the position of the tooth upon the cap. It will then be ready to be invested for soldering.

A most suitable investment for crown-work is marble-dust and plaster, equal parts, with a small quantity of fine asbestos fiber thoroughly incorporated. After the investment has thoroughly set, the wax may be removed and the surface of the backing and cap cleansed by directing upon it a small stream of boiling water. The investment should be cut away so as to expose the sides of the backing and the lower border of the band, as illustrated in Fig. 394, but every portion of the porcelain should be protected. The case should then be at first gently heated up, to drive off the moisture, then transferred to the soldering block, when, with the blowpipe, more heat should be applied, continuously at first, until the investment and tooth are thoroughly and evenly heated throughout.

Gold solder, 18-carat, is then cut in small pieces and placed, with a little borax, over the aperture between the backing of the tooth and the cap. The investment being now uniformly heated, the flame from the blowpipe should be directed upon the solder, mostly in the direction indicated in Fig. 394, when, if the entire case has been previously brought to a red heat, the solder will readily melt and flow betwen the tooth and cap. Additional solder should now be added and melted until the proper contour of the tooth is insured.

The tooth and investment should then be placed in and covered with sand, plaster, or some other suitable substance to keep the heat from radiating too rapidly and thus cracking the tooth. It should be left so covered until it is thoroughly cool. We might add here, that it is well to direct the flame from the blowpipe into the sand or other material for a moment before placing the tooth

FIG. 394.

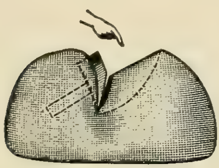
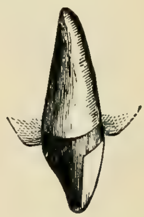


FIG. 395.



in. After the tooth is thoroughly cool, the investment may be broken away, and all oxidation and borax removed by placing it for a few minutes in the acid bath. The crown is then ready to be finished and polished. The shaping of the solder can best be done with corundum stones, followed with hard-rubber discs, and then fine sandpaper or cuttlefish discs, while the polishing is accomplished with brush and buff wheels, pumice-stone, whiting, and rouge. The completed crown in position is shown in Fig. 395.

The Richmond Method Applied to Bicuspid Roots.—The capping of the root is similar to that already described; the crown will have greater strength, however, if a portion of the palatal section of the natural crown, when strong enough, is retained, and the band made deep enough to cover it. One pin is all that is usually required, and where there are two distinct canals, the palatal should be used to receive the pin; thus greater strength is

secured at the point where it is most needed, and the pin is so located that it will not interfere with the grinding and adjustment of the tooth. The cap and pin being in position, a suitable cuspid tooth or bicuspid facing is then ground, backed, and adjusted to represent the labial aspect, and then properly secured to the cap with adhesive wax. The tooth, cap, and pin are then carefully removed, invested, and soldered; after which they are again placed upon the root, and the occluding edge of the tooth is ground clear of the antagonizing teeth at about the angle shown at A, Fig. 396.

From a suitable die or die-plate the cusps or occluding surface of the tooth are swaged from 22-carat gold plate. These cusps should then be filled in with 18- or 20-carat plate or solder. This is done by cutting the gold into small pieces, and placing them, with a little borax, in the depressions of the cusps, all of

Fig. 396.

Fig. 397.

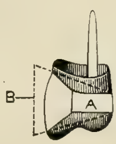
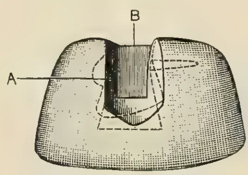


Fig. 398.



which is held over a Bunsen burner until the small pieces are melted, when they will flow into these depressions and fill them level full. The surplus is trimmed away, the cusps ground and fitted to the edge of the porcelain front, in position to secure proper occlusion (Fig. 397), and secured with wax as shown at A.

A piece of thin, pure gold plate or mica is then adjusted on each side of the crown (B, Fig. 397), the surfaces of which, if dry and slightly warm, will be held in position temporarily by pressing them gently against the side of the wax. This is all now invested together (Fig. 398).

The long ends of these side pieces, after being invested, hold them in position, as the investment should be cut away so as to expose the sides of the crown as shown at A, Fig. 398. In the process of soldering, after the case has been properly heated, the small pieces of solder and borax are placed in the aperture formed

by these sides of gold or mica (the place formerly filled with wax), and the flame from the blowpipe directed cautiously against these exposed sides (A). The solder will then flow, uniting the several parts, when more should be added until the proper contour, with perfect continuity of structure, is secured. The crown can be made without the gold or mica sides if great care is exercised in flowing the solder. There will be more surplus solder, however, to be finished off.

In finishing, the solder is brought to the contour of a bicuspid tooth with corundum stones and sandpaper discs, when it is ready for the polishing process. The finished crown is represented in place upon the root in Fig. 399.

There are other methods practised, and though some of them may not be as artistic as the one just described, they are much simpler and quicker. For instance, the palatal cusp may be built up with several pieces of gold plate—previously melted into the form of balls and flattened out with a hammer. The backing is brought down and closely burnished over the cutting edge of the tooth, which is then waxed in position, tried in the mouth, and invested, and when ready to be soldered these flattened pieces of gold are laid in position, united, and filled in with 18-carat solder, which is also brought over the backing to the tip of the tooth. This plate and solder are afterward brought to the proper shape and contour with the stones and discs.

Fig. 399.

Then, again, the palatal portion of the band is extended down so as to nearly touch the antagonizing tooth. This leaves only a comparatively small space to be filled in with solder, which is afterward trimmed and finished to the form of the crown.

Or, a method that the writer often employs is to back the tooth, grind off or bevel the occluding surface, and then joint and adjust the prepared gold cusps; wax them in position, invest, and flow in sufficient 20-carat solder to hold them securely in position, after which the tooth may be ground, adjusted, and soldered to the cap, as has been directed. One advantage of this method is that different forms and shades of bicuspid facings may be so prepared—with gold occluding surfaces—and kept in stock; and, again, in the latter three methods, as may be seen, it is only necessary to invest the cap once after adjusting the tooth.

Dr. Litch's Method.—The method devised by Prof. Wilbur F. Litch for forming collar crowns was first published in the *Dental Cosmos* (Vol. xxv, p. 449), and was afterward revised and reproduced in the "American System of Dentistry." In this Prof. Litch describes his method as follows:

"The processes to be described reduce destruction of tooth substance to the minimum. Instead of cutting the palatine wall of the tooth down to the gum margin, the greater portion of it is carefully conserved, its presence, while not indispensable to a successful result, being in the highest degree desirable. How much of this portion of the tooth can be retained will depend upon the nature of the occlusion.

"In Fig. 400 the dotted line from C to D represents the point to which the tooth is cut away in the older methods of pivoting; the dotted line from A to B, the line of abscission practised by the writer.

"As will be seen by reference to Fig. 401, the face of the tooth thus prepared presents a gradual slope from the palatal surface to the labio-cervical margin. At the latter margin the root should be cut down with suitable instruments to a point a little beneath the edge of the gum, in order that the porcelain tooth in front may pass up under the gum margin, and the joint between the tooth and root be concealed. At this point tooth substance may be sacrificed, as it does not materially diminish the strength of the root.

Fig. 400.

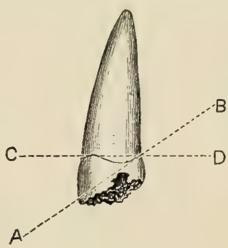
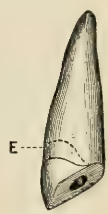


Fig. 401.



"The several parts employed in making the collar crown are a plain plate porcelain tooth or facing, a platinum-iridium retaining pin, and a backing, base-plate, and collar, made either of platinum, pure gold, or 22-carat gold, either metal being made in thickness about No. 30, American gage. When platinum is used, coin gold or 20-carat gold, alloyed with copper or silver only, should be employed as a solder and covering. Twenty-carat gold may be used as a solder when pure gold is employed, while 18-carat gold will solder the 22-carat plate.

"In shaping the pulp canal for the reception of the retaining pin care should be taken not to weaken the root by an unnecessary

enlargement of the caliber of the canal. The platinum-iridium pin need not be more than No. 14 American gage in thickness at its point of greatest diameter, near the free surface of the root, where all the strain, if any, falls; from this point it should be made a gentle taper corresponding to the natural shape of the space it is to occupy. Half an inch in length is ample; even less will serve.

"The retaining pin being shaped and adjusted on the root, care being taken to leave an excess in length at the free end for convenience in subsequent manipulations, the next step in the process is the making of the base-plate and its attachment to the pin. A strip of platinum or gold of suitable size is pressed upon the face of the root with broad-pointed, serrated instruments until it is in close adaptation to the surface at every point. This base-plate is allowed to *project beyond* and *overhang* the palatine portion of the root, but should not come quite to the labial edge.

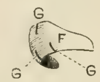
"Adaptation being secured, an opening is made in the base-plate where it covers the pulp canal, through which opening the retaining pin may be pressed up into position in the root. Pin and base-plate are then removed from the mouth, dried, and cemented with a brittle resinous cement, and then, while the cement is still plastic and yielding from heat, placed again in position in and upon the tooth, and perfect adaptation secured. While still in position in the mouth, throw upon the cement a stream of very cold water, so that it may be made brittle and incapable of bending. Then remove from the mouth and invest in a mixture of equal parts of plaster and pulverized marble, with enough water to make a thick paste. After the investment has set, solder the retaining pin and the base-plate together.

"To make the collar, a somewhat crescent-shaped piece of platinum or gold of suitable size is prepared and pressed into shape upon the palatine and palatoproximal face of the tooth; little slits may be cut in the collar with a delicate pair of scissors, to make easier this adaptation. Care should be taken not to push the collar up under the gum at any point, provided the palatine wall of the tooth, which had been allowed to remain standing, is at all ample in height—say $\frac{1}{10}$ of an inch; if less than this the collar may pass under the gum for a short distance, as will be shown subsequently. In the average case this collar will not quite encircle one-half the tooth.

"Fig. 402 shows the collar curved to the outline of the gum margin and shaped to the contour of the palatoproximal wall of the tooth. At G the slits are cut in the platinum to allow overlapping in shaping to contour.

"In order to strengthen the collar and facilitate its attachment to the base-plate cut a series of slits in that portion of the base-plate which has been made to project beyond the palatine wall of the tooth, and the base-plate, with its now attached pin, being placed with the collar in position in and upon the tooth, the little strips of metal into which the overhanging edge of the base-plate has been cut are pressed, one after the other, down upon the collar and carefully molded to its surface, so that the collar will no longer consist of a single thickness of metal, but will be reinforced by these additional thicknesses of base-plate thus pressed upon it.

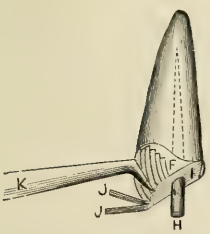
FIG. 402.



Shape of collar.

"Fig. 403 shows this quite perfectly: H is the free end of the retaining pin, which is to be cut off when the porcelain tooth is mounted. I is the base-plate, with its overhanging palatine margin cut into strips, J, which are being pressed down upon the collar, F, by the broad-surfaced and serrated instrument, K. This being accomplished, remove the several pieces from the mouth, carefully cement the collar in its proper position relative to the base-plate, which will now form a sort of matrix for it, again place in the mouth, readjust, harden the cement, remove from the mouth, invest as before, and solder the collar and base-plate together, using a considerable excess of solder for covering, so that the collar may be still further strengthened and its surface be made uniform.

FIG. 403.



Pressing the base-plate over the collar.

"In cementing the collar to the base-plate one precaution is imperative—namely, not to allow a film of cement to get between the collar and the tooth. If this is done and the investment poured in upon this film of cement, the latter will immediately burn out as soon as heat is applied, leaving a space between the collar and the investment into which the gold solder will flow, and thus interfere

with that perfect adaptation of the appliance to the tooth which is necessary to a successful result.

"The mounting of the facing next demands attention. As already stated, a plain plate porcelain tooth is used. This must have what are technically known as cross-pins; that is, pins placed at right angles with the long axis of the tooth. They must also be placed well up toward the cutting edge. If they are too near the neck they will inevitably be cut out in fitting the tooth to the slope of the base-plate on which it must be mounted.

"Fig. 404 shows the form of the facing and indicates the slope given it in fitting. The fitting process does not differ from that ordinarily employed with porcelain teeth; an impression may be taken and the work done on a cast, or the facing may be fitted to the mouth. In either case it is in the mouth that the finer and final adjustments as to height, contour, alignment, etc., must be perfected.

Fig. 404.

Shape of porcelain facing.

"This being done and the facing backed, tooth and base-plate are cemented together, restored to the mouth, finally adjusted, removed, and soldered as before, as much gold being flowed into the angle between the backing and the base-plate as occlusion will permit.

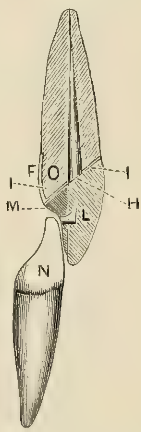
"This artificial crown, being properly finished and cemented into position in and upon the tooth, makes what the writer, from several years' experience in its use in a large number of cases, has found to be an appliance which will remain for an indefinite period without the slightest deviation from position and alignment, and which in many respects is almost as strong as the natural tooth, because its point of greatest resistance to pressure is placed where Nature anchors her enamel walls—namely, upon the *outside* and not upon the inside of the walls of dentine; so that in the act of occlusion the force applied by the lower incisors as they come up in position *inside* the upper incisors falls upon the *whole* thickness of the root *through the collar,* and not upon less than half its thickness through a centrally anchored pin—a pin, too, prolonged into a lever of enormous power by its attachment to the porcelain tooth.

"In this respect there is a manifest weakness in all methods of mounting artificial crowns which depend for their stability solely upon the central pin. Ultimate failure through splitting of the

root is the frequent result, and the larger and stronger and more deeply anchored the pin the more certain this result, because a large pin necessitates a large opening for its reception, and a corresponding weakening of the root, upon which the strain must ultimately fall: the lever is strengthened and the point of resistance weakened.

"The only safety for the usual form of pivot tooth is, either that the occlusion shall be slight, the root very strong, or the pivot very flexible or elastic. This elasticity of the old hickory pivot was one of its chief excellences: roots were much less likely to split than with a rigid, unyielding metallic pin. In cuspids or incisors, however, metallic pins, unless enormously large, or thickly packed around the amalgam, will very often bend outward, thus allowing a slight displacement forward of the artificial crown, and to that extent relieving the root from strain.

Fig. 405.



Sectional view of collar crown in position, the lower incisor in occlusion.

"Fig. 405 gives a sectional view of the collar crown in position, the lower incisor being in occlusion. L is the porcelain facing. H is the pin attached to I, the base-plate. M is the backing and solder. N is the lower incisor, and F the collar. It is clearly evident that here the force of occlusion falls upon the palatine wall of the natural tooth at O through the collar F, and not upon the pin at the point of its attachment to the base-plate H, and through the pin upon the thin outer shell of the root.

"In cases frequently met with, where the entire crown of the tooth has been removed, the collar, as before described, can be adapted to the palatine face of the root, provided the latter be not decayed away up to the alveolar margin. Usually, however, there is a considerable space between the free edge of the root and the alveolus, and here, running up to the alveolus, the collar must be placed.

"The dotted line E in Fig. 401 indicates a collar so placed. All the steps in the process are essentially the same as before described. Adapting the collar to the surface of the root beneath the gum is somewhat painful, but not excessively so, and in the

wearing the irritation caused by its presence is very slight and transient in character, assuming, of course, that care has been taken to leave upon it a smooth, thin, and well-polished edge.

"The objection may be urged that this form of crown resists pressure only in one direction, from within outward, and does not provide for lateral pressure or pressure from the front. As a rule, the latter can occur with any force only as the result of accident, while if the crowned tooth is in normal relation with its fellows, and the artificial crown be closely fitted between them, they will fully sustain lateral force.

"Where such lateral support is wanting through isolation of the tooth, the collar must be extended into a ring or ferrule completely encircling and grasping the root, and thus affording support on all sides. The ring, however, is more troublesome to make and more painful to apply, and generally shows a line of gold in front. In the average case the simple collar gives all requisite strength.

"In mounting crowns upon bicuspid and molar roots, however, the ferrule principle is often essential to stability; especially is this true of lower bicuspids and molars, as here the forces applied in mastication are as erratic in direction as they are powerful in character, and the root must be guarded at every point against their violence.

"In fixing in position the artificial crowns just described, the writer prefers to use a gutta-percha cement adhesive in character, which will not strip from the pin when the crown is forced into position.

"The apical foramen is closed, the pulp canal grooved and thoroughly dried, the central pin is barbed, and the pin and inside of the collar and under surface of the base-plate are thickly coated with the gutta-percha; the entire appliance is then heated to a temperature sufficient to thoroughly soften the gutta-percha, and firmly pressed up into position; the excess of gutta-percha will ooze out at all free margins, and may be subsequently removed with suitable instruments.

"A good gutta-percha cement will hold firmly in a great majority of cases, but when, as in a small lateral incisor, the retaining pin is necessarily small and short and the collar not as ample as could be desired, an oxyphosphate cement, mixed thin, will be found to give greater stability. When this cement is used, however, it will

be found very difficult to detach the artificial crown from the root, should it for any reason become necessary to do so; whereas a little heat will quickly soften a gutta-percha packing and permit the entire appliance to be withdrawn without difficulty."

As a modification of the manner of constructing the collar, Dr. Theodore F. Chupein contributes the following to the *Dental Cosmos:*

"After the root face has been dressed down as shown in Fig. 401, a piece of pure gold plate of No. 30 gage is cut as shown in Fig. 406. This is bent around the root, as shown in Fig. 407, the wide part resting against its palatal aspect, while the ends are seized with a pair of narrow-beaked, flat-nosed pliers at the labial aspect. While thus held, the band may be burnished to fit accurately against the approximal and palatal parts of the root. This done, it is removed and the ends soldered together, as shown in Fig. 408.

Fig. 406.

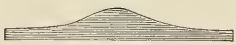


Fig. 407.

Fig. 408.

Fig. 409.

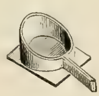


Fig. 410.

Fig. 411.

This band is then replaced on the root, and, as it hugs the root snugly, any of the edges which may be higher than the face of the root may be ground down even with a corundum stump wheel. It is again removed from the root and laid on a piece of pure gold plate of the same thickness, to which it is soldered, as in Fig. 409. The overhanging edges of the plate, as soldered to the collar, are now dressed down even with the collar, and the forward part of the collar filed or ground away from the plate, as shown in Fig. 410. A hole is now drilled or punched through the face-plate to receive the dowel, which passes through it into the root. The under part of the face-plate at the hole should be well countersunk, so that the solder that binds the dowel to the face-plate may creep through and hold the dowel on its under surface. The face-plate and collar, as shown at Fig. 410, are placed on the root and burnished down to fit accurately at all points. A slight smearing of

cement is placed over the dowel hole, so as to fill the countersink, and the dowel passed through and secured to the face-plate with more cement. Before this hardens it is placed on the root in its proper position, after which the cement is chilled by a stream of cold water, when it is removed, invested, and soldered. Fig. 411 shows the collar, face-plate, and dowel complete. This being accomplished, the face-plate is slightly reduced on its labial aspect, so as to expose the root against which the porcelain facing is to rest. The protruding part of the dowel is now cut off level with the face-plate, and the porcelain tooth fitted to it. This part of the operation does not differ from that indicated by Prof. Litch, and therefore need not be repeated here.

"The operation as set forth consumes much less time, is less tedious, does not demand the nice manipulative ability of the other, and is more certain in its results."

Dr. Knapp's Process.—No individual method has, perhaps, more immediately and generally commanded the approval and commendation of expert and discriminating operators than the one brought to the notice of the profession by Dr. J. Rollo Knapp, of New Orleans, La. Omitting some judicious and pertinent general reflections on the subject (see *Dental Cosmos,* of February, 1887), all that relates to practical details in his methods of procedure is here reproduced:

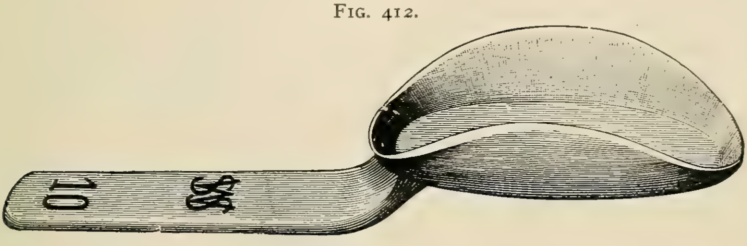
"The collar being removed, its gingival border must be carefully filed so as to adjust it exactly to the various inequalities existing in the borders of the alveolar process and its investing gum. The other border should then be evenly filed down so as to reduce the collar to the requisite narrowness. A piece of pure gold plate, gage 34, is now to be soldered upon this latter border so as to convert the collar into a cap for the root. This cap must have pierced in it such an aperture as will conform to the configuration of the pin or dowel best suited to the particular case in hand. Cap and pin waxed together, should then be tried in the mouth, carefully removed, invested in calcined marble-dust and plaster, and soldered. Being again placed upon the root, an impression of it should be taken, as well as of the two approximal teeth."

Small trays especially made for the purpose (Figs. 412 and 413), will be found very convenient for taking impressions for crown-work. Plaster or modeling composition can be used in doing this.

Upon its being ascertained that the cap, with pin attached, is in its proper position in the impression, a plaster cast can be obtained, which, with a cast of the occluding teeth, should be placed in an articulator.

While the writer believes it to be the most accurate, when making single crowns, to grind and adjust the tooth in the mouth,

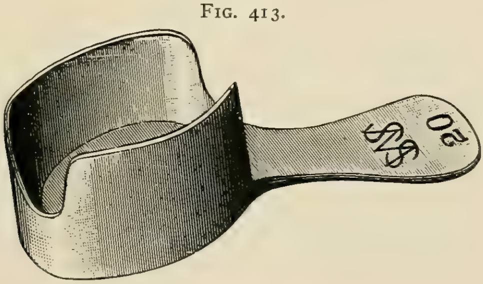
FIG. 412.



it frequently happens, from lack of time or other reasons, that it is not practicable; then the impression should be taken as directed.

From this point succeeding steps will differ according to the character of crown to be inserted. If it be an incisor, which is to have a porcelain front, a plain plate tooth of suitable size, shape, and shade should be backed with pure gold, ground to position upon the anterior portion of the cap, and united to it by adhesive

FIG. 413.



wax. Sufficient wax should be used to perfectly restore the contour and to produce the most accurate *knuckling* or adjustment of the approximal surfaces of the teeth. Too much stress cannot be laid upon this latter point—one not usually attended to. Yet all the reasons for observing it in all other kinds of contour work are no less potent here. In this procedure pure gold of 34 gage

should be made to completely envelop the sides and incisive portion of the wax, including the edges of the backing and contiguous portions of the cap. All should now be invested, the wax removed by boiling water, drying effected by a gentle heat, and the resulting golden pocket filled with 20-carat solder. The solder, previously cut in small squares, is to be dropped into the mouth of the mold, and sprinkled with a very little powdered borax—repeating this process with the left hand as fast as the solder is melted under the blowpipe while held in the right hand until the mold is quite filled. To accomplish this in the best manner the flame of the blowpipe should be quite intense, but at the same time exceedingly small.

The small and deep mold formed by the gold shell enveloped in the marble and plaster matrix has a very narrow opening, which renders necessary an intense heat, capable of concentration upon and easy application to the innermost recesses of the mold, which is to be filled with molten gold. An oxyhydrogen blowpipe* was therefore constructed to utilize the condensed nitrous oxid gas in combination with common illuminating gas for the production of a mixture which is conducted through a thin rubber tube of 1/8 of an inch bore to a very small blowpipe, which emits a steady flow of constantly ignited gas in the form of a pointed pencil about 1/2 of an inch in length by 1/4 of an inch at its greatest diameter. With this blowpipe in hand, the plaster matrix may be speedily heated by playing the stream of fire over its surface until the mass is aglow, when the point of the flame is thrown into the mold by rapid thrusts until the solder melts like wax and fills every part of the mold with liquid gold. From the first application of the flame to the previously dried and warmed matrix, there is usually no more than ten minutes consumed in bringing the solder to the fusing-point and completing the cast of gold in the little mold. It would seem that by such means only can the requisite heat be obtained, directed, and controlled with the sensitiveness of adjustment that admits of the 20-carat solder being melted in, yet without destruction of, the thin gold crucible within the matrix. After cooling, removing investient, and boiling in acid, superfluous solder can best and most expeditiously be removed by corundum wheels

* See page 45, Fig. 20.

on the engine. Care should be taken not to cut away the gold forming the approximal knuckling, and to artistically carve the palatal portion.

Fig. 414 represents a band of collar gold, 22 carats fine, 28 gage; Fig. 415, a soldered collar or ferrule made from it; Fig. 416, a square gold pin, 20 carats fine; Fig. 417, a plate of pure gold, 34 gage, for a cap; Fig. 418, the collar, cap, and pin duly invested. Fig. 419 represents the collar, cap, and pin soldered together with 20-carat solder; Fig. 420, a lateral incisor plate tooth, backed with pure gold, 28 gage, ground to the anterior portion of the cap, fastened to it with wax, contoured to represent a natural incisor, the approximal sides as well as incisive portion of which, together with the edges of the gold backing and contiguous parts of the cap, all enveloped in pure gold, 34 gage. Fig. 421 represents the

FIG. 414.

FIG. 415.

FIG. 416.

FIG. 417.

FIG. 418.

FIG. 419.

same, invested in calcined marble-dust and plaster, the wax removed, disclosing the golden pocket ready for the reception of the solder. Fig. 422 shows the crown after the soldering has been effected; Fig. 423, the lateral incisor crown divested of superfluous solder and completely finished.

In constructing a cuspid, its natural palatal characteristics should be as accurately reproduced as practicable, Figs. 424, 425, 426, 427, and 428. The formation of a porcelain-faced bicuspid is similar to that which has just been detailed, up to the soldering of the backed tooth to the cap, Fig. 429. The subsequent stages, however, are very different. The perfect configuration of a bicuspid should be reproduced in wax, aptness of occlusion and knuckling being carefully attended to, Fig. 430. In this condition the crown should be placed in a small ring, such as is shown in Fig. 431, first set with wax in the desired position, and then secured there by plaster.

The exposed portion of the crown and surrounding plaster should then be coated with sandarac varnish and molded in marble-dust and glycerin, contained in a corresponding annular section, Fig. 432. Over this is to be placed a conical tube, such as is represented in Fig. 433, and into which molten zinc is to be poured.

FIG. 420.

FIG. 421.

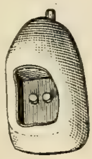


FIG. 422.

FIG. 423.

FIG. 424.

FIG. 425.

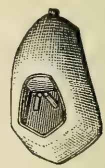


FIG. 426.

FIG. 427.

FIG. 428.

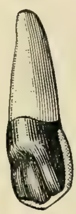


FIG. 429.

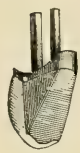


FIG. 430.

FIG. 431.

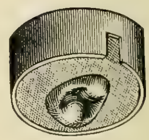


FIG. 432.

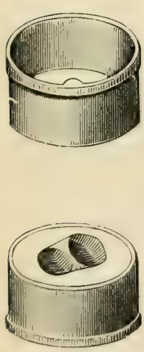


FIG. 433.

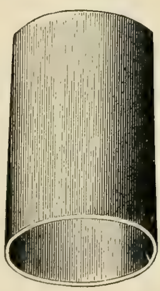


FIG. 434.

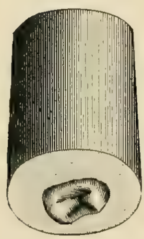


FIG. 435.

FIG. 436.

FIG. 437.

With the die, Fig. 434, thus cast, in accurately reproducing the natural cusps and sulci, there can be obtained with pure gold plate, 34 gage, a perfect counterpart of the grinding surface of a bicuspid crown, Fig. 435. The palatal cavity of the impression thus made in the plate must now be filled with gold solder, 20 carats fine,

after which the piece must be finished up by any requisite trimming. Care should be taken to leave the palatal cusp entire, and just enough of the buccal or external cusp to combine with the porcelain face in the formation of a proper occluding surface, Fig. 436. From the model, as represented in Fig. 430, sufficient wax

FIG. 438.

FIG. 439.

FIG. 440.

FIG. 441.

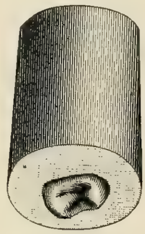


FIG. 442.

FIG. 443.

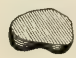


FIG. 444.

must now be displaced to permit of the prepared gold cusps assuming their proper position, and the approximal surfaces remaining in the wax then enveloped with pure gold, 34 gage. The palatal portion of the collar must be protected with a strip of pure gold, 28 gage, $\frac{1}{16}$ of an inch in width. All is now ready to be invested, Fig. 437. After removal of the wax, through the palatal aperture

FIG. 445.

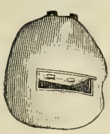


FIG. 446.

FIG. 447.

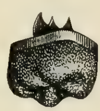


FIG. 448.

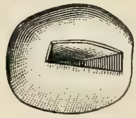


FIG. 449.

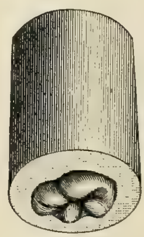
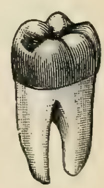


FIG. 450.



remaining, the internal walls of gold will be disclosed, Fig. 438. By careful manipulation with the small and intense blowpipe flame before mentioned, 20-carat solder can be so flowed in as to make a solid golden mass, from which can be readily shaped a perfect bicuspid, Fig. 439.

In the construction of an all-gold bicuspid crown some of the steps differ from those just described. Upon the cap are dropped several beads of wax. From this shapeless mass is carved a perfect bicuspid, Fig. 440. A die is then obtained, Fig. 441, after the manner just detailed. A grinding surface is swaged in pure gold, Fig. 442, and the cusps are filled with 20-carat solder, Fig. 443, and placed in proper position upon the wax tooth. A piece of pure gold plate, slit at the edges for facilitating adjustment, should now be made to cover about two-thirds of the yet exposed border of wax, Fig. 444. After being invested, and the wax removed by hot water, a suitable aperture is left for soldering, Fig. 445. The resulting completed bicuspid, true to nature, is seen in Fig. 446. The descriptions just given answer for all-gold molars, Figs. 447, 448, 449, and 450.

In carving the cusps and sulci, and in otherwise modeling the gold parts of the crowns, small engine corundum wheels and points, varying from coarse to fine, and barely moistened, to insure accuracy and delicacy of touch, are preferable to files or any form of steel instruments. The smoothing and polishing is done with wet felt wheels, fine pumice, pulverized silex, moose-hide points with chalk, brush wheels and whiting, and finally with rouge. It is a matter of much importance that great care should be exercised in the preparation of the gold used. The solder should be uniform, flow easily, and conform well in color to the work in hand.

Dr. Shields' System.—The following methods, first published in the *Dental Cosmos,* are contributed by Drs. N. T. and L. N. Shields. " The points in this work to which we desire to direct attention are its permanency, absolute cleanliness, and artistic beauty. By the methods herein described the crowns are constructed upon anatomical lines, larger at the grinding and cutting surfaces, so as to admit of thorough mastication of food without injury to the gums. The ordinary shell crowns are positively wrong in shape and construction, because the normal crown has a larger diameter than the neck of the tooth, therefore a band made to fit the crown of a tooth tightly will be too large at the neck. This will necessarily leave a space for the lodging for food debris, although it may go under the gum, will make the gum present a very unnatural appearance, will make the gold tooth altogether unnatural in construction, and the result, after a very few years, will be a mass of

decay under the shell crown, which makes it not only a temporary operation, but a constitutionally as well as a locally injurious one.

"The enamel widens or becomes thicker the nearer it approaches the grinding and cutting surfaces, and in order to get a perfect junction of the collar crown and the neck of the tooth we must remove *all* enamel." Their procedure is as follows: First destroy the vitality of the pulp, then extract all of it with Donaldson's nerve canal cleansers. With a little patience and using No. 5 all fine, and for every sitting a new cleanser, every particle should be removed from the roots, when they should be perfectly filled to their respective apices. This done, the whole crown is cut off almost even with the gum; there will still be a thin portion of the enamel left surrounding the root, and this can easily be removed by using the No. 2 and No. 3 scalers made by the S. S. White Dental Mfg. Co. (See Figs. 451 and 452.) This done, shape the root for a solid all-gold crown, as shown in Fig. 453. The procedure in the case of porcelain faced crowns will be described later.

Fig. 451. Fig. 452. Fig. 453.



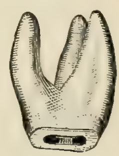


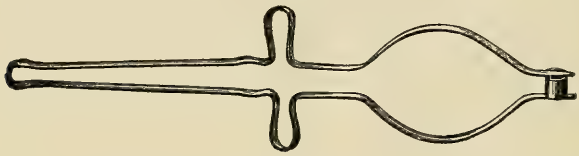
Fig. 454.

Around this conically shaped root (the removal of the enamel alone will generally shape it sufficiently) fit a 22-carat gold band so as to come in contact with all parts of the conical portion of the root, which, when made, naturally gives a conical band. To make this band, first make a tin-foil model, as seen in Fig. 454; this causes less pain to the patient. From this an absolute shape in gold is obtained more quickly, and a saving of gold results. This band is soldered with 22-carat solder, then placed in position, and its free margins ground down even with the root end.

Next prepare the band for a pure gold floor by taking a Butler corundum point and hollowing out the upper or small end by beveling from the inside edge so as to allow room for the solder. Although only an infinitesimal amount of solder runs inside, still there must be a place for that little to flow; otherwise the band could not go back into place, on account of the solder flowing inside, and we must have the solder to flow inside in order to make a complete cone externally. Now take a piece of pure gold (No.

34 American gage) and cut just a little larger than the band, anneal it, and adapt it perfectly, then place the two in a No. 7 Melotte soldering clamp (Fig. 455), and be sure they do not move; place borax, mixed with water to a thin cream, all around the overlapping edge of pure gold, place a small piece of 22-carat gold solder at the junction of the band and floor, and with a broad, gentle flame solder the entire floor with the one piece of solder and at the same moment. The clamp holds them firmly together, and

FIG. 455.



the work can be placed back on the tooth without rocking. (Fig. 456.)

Now make the pivots or dowels (of platinum and iridium wire), and roughen them before placing in position. Drill holes corresponding with the root canals, place the pivots in position, and fasten them to the floor with prepared hard wax. Now remove carefully, and invest pivots, floor, and band in equal parts of plaster and marble-dust, and, after removing the wax with boiling water, unite them with 22-carat gold. Now cut down the over-

FIG. 456.

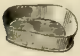


FIG. 457.

FIG. 458.

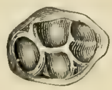


FIG. 459.

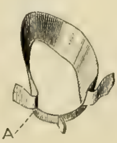
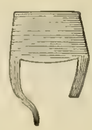


FIG. 460.



lapping pure gold floor exactly even with the band, also cut down the projecting ends of the pivots. This constitutes the foundation for a solid gold crown. Never make pivots for canals which cannot be thoroughly filled with cement. It is better to shorten the pivot somewhat and make it thicker, and depend for anchorage only upon the lower part of the canal, as shown in Fig. 457.

Now put the foundation in its position in the mouth (upper jaw, for example), and take an impression of the whole upper jaw in

modeling compound, also take an impression of the whole lower jaw. Remove the foundation, and place it with great care exactly in its proper matrix in the impression just taken, then stay it to the modeling compound with wax in two or three places; be careful not to move it with the wax knife, dry the pivots and band on the inside, and cover the pivots with a film of wax, also run a film of wax around the band on the inside, but be sure to remove all wax from the edge of the band, because we want that to rest firmly upon the plaster. Now fill the impression with plaster to make a model.

After separating the model, remove the crown foundation from the model by making a hole, usually on the palatal surface, with a pocket-knife, through the plaster to the apical end of the pivot. Now place the model and foundation in hot water, and with a little pressure on the end of the pivot the whole foundation is easily removed. Syringe out all wax from the model and foundation; the latter should then be replaced upon the model.

Next make the stamp for a grinding surface; use for this pure gold, 34 American gage, and fill in the cusps with 22-carat solder. Melotte makes a very fine set of steel stamps that one can generally make use of, but a zinc cast can be made in a few minutes by simply placing White's prepared molding sand, always ready for use, in a ring and gently imbedding the grinding surface of a suitable tooth, and in a minute by the watch a small quantity of zinc can be melted and poured into the impression in the sand. The molar or bicuspid stamp is made in the usual way by placing the pure gold, always well annealed, on a piece of lead and striking a few light blows on the die, which gives a perfect grinding surface, as seen in Fig. 458. This is the reverse side of a stamp of a superior left first molar.

Next trim off all surplus gold, leaving the grinding surface as represented in the cut. The cusps are next filled with 22-carat solder. The reason 22-carat solder is used is, when the whole space between the grinding surface and the foundation is filled in with 20-carat solder there is no danger of the 22-carat being melted out of the cusps, and consequently no danger of having an air-bubble just under the grinding surface which, of course, would make itself visible after a few days' use.

Having taken a full impression of both upper and lower jaws, an absolutely correct articulation is secured. Now add wax to the

foundation, which can be removed from the plaster, until an exact articulation with the pure gold grinding surface is produced. After having gotten this with hard wax so that it may be manipulated without disturbing its position, continue to build out the tooth to its anatomically correct contour with wax, frequently trying it into place. After the foundation is removed from the plaster, the plaster is cut away from between the foundation and the adjoining teeth without disturbing the plaster upon which the band rests. When this plaster is removed, wax is added up to the very edge of the band, so that the entire anatomical contour can be restored with gold, including even that of the enamel chipped off at the cervical margin. The wax tooth should always be tried in the mouth, to be sure that everything pertaining to form, contour, and position is just right. This was the object of removing the foundation from the plaster model at the outset, as it is a great advantage, and particularly so with facings, to always just at this time try the tooth in the mouth.

FIG. 461.

Now from a piece of tin-foil (No. 60) a model is cut so as to fit the wax exactly. We cut the gold on the palatal surface from the height of foundation (see A, Fig. 459), thereby enabling us to join the free ends at the cervicopalatal surface. The large ends of the gold we turn out and back, to stay it in the investment of plaster and marble-dust. The gold can be cut a little long, to allow of bringing the cervical ends together. This cervical margin is very important, as shown in Fig. 460. Sometimes three pieces of gold are used instead of one, but if so the pieces of gold should always be cut with projections (as seen in Fig. 459) to retain the exact shape of the tooth and not pull it from the instrument when soldered. This gold band must fit just under the edge of the grinding surface stamp, and be in perfect contact with it, so as not to allow the grinding surface to move. This little thickness of pure gold (No. 34 American gage) must be allowed for waxing up the tooth.

Now we have the wax tooth thoroughly boxed in, excepting the palatal surface. Before taking the next step, be sure that the pure gold band for boxing is in contact with the cervical margin of the foundation band. At the point of junction here and at the grinding surface place a little wax, and then cut all possible surplus away,

leaving only the very junction filled; also be sure no wax gets on the inside of the cervical margin of the foundation band. Now place the tooth in water and invest it in plaster and marble-dust, covering the whole tooth except the palatal surface of the crown; the plaster must just cover the narrow gold joined at the cervical margin. After the plaster sets, boil out the wax and cut the investment as small as possible, leaving the plaster only about 1/8 of an inch all around. Now dry thoroughly, but not in contact with a flame; have something—a top of a tin box, for instance—between the flame and the tooth. After it is dry, place it in the flame of a small Bunsen burner. To hasten the heating up process, a foot blowpipe may be used to get it red-hot very quickly, but nevertheless the heating up is to be done cautiously, and during this time we still have the little Bunsen flame under it. Now, by applying the flame of the Knapp blowpipe, the gold flows with the greatest ease in all parts and in all directions. Here use 20-carat solder. Fill the molar about half full with gold, using borax as a flux, before using the Knapp blowpipe.

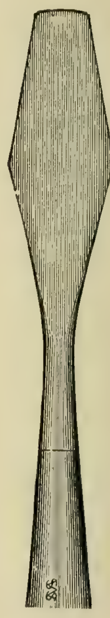
It should be observed that we have the solder almost to the melting-point, everything is red-hot, and a hot flame beneath the investment, so that when we gently apply the blowpipe flame the gold simply drops, and while in this molten condition add the rest of the solder, never allowing it to cool for one moment, for if it does air-bubbles will result. Here the gold boxing band at the cervicopalatal margin does its work beautifully; the gold flows freely all around, with no danger of solder running inside the foundation from the palatal side. The plaster and marble-dust should always be worked as stiff as possible, so as to always have the gold in contact with plaster, which will not be the case if the investment is mixed thin. The necessity of having everything firmly held, so that the gold solder will not pull it in and change the entire shape of the crown, becomes evident when the large amount of solder used is considered. This being a solid crown, we put it in water to cool, and next in very dilute sulphuric acid, and gently heat it to remove adhering borax and oxidation. Now we can shape the gold to anatomically correct contour lines and bring the cervical margin down to a feather edge, so that when again placed on the root we have an absolute junction without a lodging place for acids, and the whole tooth restored to a state of perfection. (See Fig. 461.)

In the construction of a crown with a porcelain face, the root is shaped just as for a solid crown, excepting that it is cut under the gum on the labial surface, and also lower on the palatal surface, so as to remove all enamel (Fig. 462). After cutting under the gum hold the gum back by anchoring premium gutta-percha in the root canal and press it over the labial surface. After the crown has been set, the gum comes down beautifully over the gold band and prevents its being visible. Prepare and complete the foundation the same as for the solid crown, taking impressions, bite, etc.,

FIG. 462.

FIG. 463.

FIG. 464.



as before, and select the shade. Now prepare the facing carefully as follows: Grind the facing shorter than you desire by the thickness of No. 34 gold plate; grind off both angles left at the cervical portion, and also grind the cutting edge on the palatal side from pins to cutting edge, leaving a feather edge at the cutting surface; likewise grind the cervical portion from pins to cervical margin, leaving this margin also a feather edge; also remove angles from pins to approximal margins, the object being to give a perfectly convex contour to the palatal side of the facing.

After grinding off the heavy angles with the lathe, use discs in the engine, and be sure that all angles are removed. Sometimes it is even necessary to go between the pins with a disc. Now take Scotch stone and make the surface perfectly smooth, edges particularly, or the gold cannot be brought in absolute contact. Three different views of a facing so prepared are shown in Fig. 463. The surface where the pins are being the highest part, the grinding of the palatal surface is done so as to fill in with 20-carat solder and give all the strength that would be obtained if we ground the cutting edge off square, for when the tooth is finished we have a slightly beveled surface of gold at the cutting edge, the facing hav-

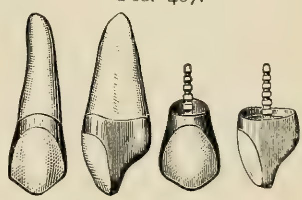
ing only a feather edge; but that edge is well protected, so we get great strength. We secure, besides, artistic beauty by having the facing exactly the shape of the natural tooth on the whole labial surface. By this method of shaping the facing we never have a tooth to crack, because there are no angles, and, finally, the solder will flow perfectly around the cervicolabial surface.

Now take this facing (being sure that the palatal surface is clean) and back it with pure gold, No. 34, allowing the gold to project a little at both cervical and cutting edges. In order to back this facing so that the pure gold is in absolute contact with the facing, anneal several times, each time pressing it in contact with the facing with a broad instrument like a plastic spatula No. 20 (Fig. 464). Never stop annealing and working to place until the tooth can be held in contact with the backing at the cutting edge and permits no motion of gold at the cervical margin. The same with the

Fig. 465.

Fig. 466.

Fig. 467.



approximal surfaces. Now hold the tooth and backing tightly between the thumb and middle forefinger, and with the point of a pocket-knife push the gold into hard contact with the pins all around, using the very point of the knife, and there will be no occasion to bend the pins; besides, it makes a perfect gold surface.

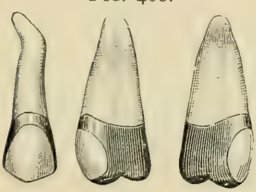
Place the facing with its backing on the foundation, wax up with hard wax, and try it in position in the mouth. If doubt exists as to the correctness of the position, stay it well with hard wax, then try again for position. After obtaining it, finish waxing up until the contour is anatomically correct, leaving a little margin all around the backing so as to be perfectly boxed in. This is done, just as in the case of the molar, by making a tin-foil model (Fig. 465) and bringing the gold into absolute contact with the backing, because if a small space is left borax will run through and crack the tooth. Great care must be exercised with regard to this contact.

This cuspid box may be made in two pieces, joined at the cervico-

labial surface the same as seen at the cervicopalatal and cutting edges. When we bring the gold across the cutting edge, which has the gold projecting a little, not bent over the edge but projecting in perfect contact, make the pure gold go just a little lower than the cutting edge, so as to have a little bevel of 20-carat gold, so slight that it cannot be seen (Fig. 466). For exceedingly heavy use leave the bevel a little thicker, but even that is scarcely noticeable. Now fill in the junction of the boxing with the backing, and also of the cervical margin of the foundation with wax, and invest the same as for a solid crown, allowing the plaster and marble-dust to come over the cervicopalatal boxing, etc.

To solder this crown, place but a few pieces of 20-carat solder and borax in before using the blowpipe, because we want the first gold to flow perfectly at the cervicolabial surface and so avoid air-bubbles, after which the course is clear. After the soldering is completed, place the crown under a little box, so that it may cool off slowly and no draft can reach it. When cold, boil in dilute sulphuric acid. This gold will cut down absolutely in contact with the tooth, and when the cutting edge is finished with a slight bevel, it will be seen and understood what great strength has been secured, with, at the same time, a beautiful labial facing of porcelain. When the cervical surface, in fact the whole crown, is finished up in the thorough and artistic manner of which it is capable, it becomes a piece of perfection. (See Fig. 467.)

Fig. 468.



A bicuspid is made exactly the same as a cuspid, with the exception of the stamp. Make the stamp, and fill the cusps with 22-carat solder, then hollow out the buccal cusp to fit the cusp of the facing, and place a very narrow piece of pure gold at the junction on the buccal surface, and continue as in the cuspid. (See Fig. 468.) If the bicuspid is a short one, do not be afraid of cracking the facing; grind and make it exactly as directed, and it will not crack. Notice the curve in the bicuspid cut.

For a bridge tooth, take a superior right cuspid. Now, when grinding a tooth to fit the gum we necessarily expose the small porosities in the body of the tooth, which always have a tendency

to lodge food, thus producing an offensive breath. To correct this defect, shape up this cuspid exactly the same as if we were making a crown, and back it up the same way. Now flow wax over the whole surface, and regulate the thickness of the wax according to the required fullness of the tooth, boxing in with pure gold the height of the wax and restoring the shape of the lost tooth; then invest to the top of the boxing, and after the proper steps of investing fill in with gold. Here there are two great points to observe. First, this gold can be finished absolutely smooth, so that nothing can collect in the way of food, hence nothing but perfect cleanliness can exist. Secondly, any amount of absorption of gum can be counteracted by building out with gold exactly the amount of absorption. This will give the tooth a natural position, a perfectly smooth palatal surface, and restore the lip to its normal, or, in case of a cuspid, almost normal, expression.

Dr. Mason's System.—It has long been the desire of the profession to overcome the annoyance caused by the breakage of the porcelain facings in crown- and bridge-work. Many efforts have been made to produce detachable facings, but prior to the introduction of the Mason crown none has been designed that could be manufactured and sold to the dentist for his immediate use. Through the efforts of Dr. W. L. Mason, a system of corresponding dovetail and groove, and a process of manufacturing whereby a porcelain facing is made independent of its backing, has been devised. Figs. 469, 470, and 471 represent the manner of constructing a superior cuspid crown. Fig. 469 shows the root, prepared in the usual way for the reception of a collar crown, with the Mason metallic backing adjusted to same; also the back face of a cuspid facing, showing the dovetail attachment, which is baked in the body of the tooth. Fig. 470 shows the same tooth being adjusted to the backing, while in Fig. 471 we have the crown complete, the same principle being carried out in any other tooth and in bridge-work.

The tooth, with its dovetail, is fitted to the band by grinding out where necessary. Then the gold backing is waxed to the band, and, after wax is hard, the porcelain is removed from its backing, by taking hold of extended portion of dovetail, and drawn from same. The crown without the porcelain, is now ready to invest for soldering. First the dovetail groove is filled up with Mason's invest-

ment material, to keep out the solder, which it will do perfectly, then the piece is invested as usual, letting the plaster come well over the cutting point of backing. It is now ready for soldering, and can be heated up, soldered, and cooled off as quickly as desired. After removing from investment, the groove should be thoroughly cleansed and dried; also the dovetail in porcelain. Now take some chlora-percha, quite thick, fill up groove, and press porcelain home. Saw off (never cut) the extended portion of metal dovetail and finish as usual. Porcelain can also be cemented on with cement or sulphur. For use as a dummy, articulate to position, remove, and solder "stop" to neck of backing to prevent porcelain from slipping upward; replace on model, join parts with wax, then withdraw the porcelain and invest.

The advantages gained by this method can only be appreciated

Fig. 469.

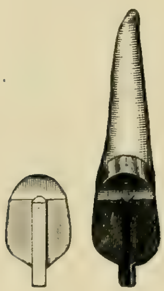


Fig. 470.

Fig. 471.

by practice. The *first* is that we do not, at any time, have to place the teeth under the flame of the blowpipe; *second,* we are not annoyed by the changing of color which takes place in soldering; *third,* a solid backing, without bubbles; *fourth,* the invested piece can be quickly heated, soldered, and cooled; *fifth,* the small amount of solder necessary—just enough to join parts together; *sixth,* saving the porcelain from being etched by borax; *seventh,* we are able to fit a bridge releasing the strain by cutting and resoldering and not have the porcelain interfered with; *eighth,* the most important of all, the amount of time saved to the busy dentist in making repairs, it being accomplished in a few minutes.

THE ALL-GOLD CROWN OR CAP.

In the construction of the all-gold crown, the sides of the natural crown and neck of the tooth are brought down to, or a little smaller than, the size of the root. This is best accomplished by the use of diamond discs and small corundum stones on the dental engine. From the occluding surface, if any of it remains, a sufficient amount should be ground away, and the edges slightly rounded, to allow the introduction of the gold cusps. The measurement and making of the band is the same as described in connection with the Richmond collar crown (see p. 503), excepting in the width of the ferrule. This should extend from the root, below the gum-margin, to within a line of the occlusion with the antagonizing teeth. After soldering and adjusting, the band should be shaped and contoured with burnishers and suitable pliers, the smooth, round-nosed, answers very nicely. The surface of the band to which the cusps are to be attached should then be brought down perfectly smooth and flat with a fine file; readjusted carefully to the root, to make sure that it has not been so distorted by the different manipulations that it will not pass readily to place and fit the root perfectly at every point. Finding all correct, the next step is making the cusp.

A number of methods have been put forward for making gold cusps. The two that have proven most satisfactory are the use of the die, such as described in connection with the Knapp system of making crowns, and by means of the die plate as described by Dr. E. T. Starr, in the *Dental Cosmos,* as follows:

In the construction of metal cap crowns to cover natural teeth or roots there are many methods which result in good work, but in most cases the caps do not articulate as well as they might, for the reason that means for embossing the bicuspid and molar cusps are not at hand, or available within the short time at the disposal of either the patient or the dentist. With the object of providing an easy and quick way of working under such circumstances, I have made a single plate, Fig. 472, in which are four groups of intaglio dies, representing with distinctive correctness the peculiar cusps of the upper and lower right and left bicuspids and molars. These are indicated by the Hillischer notation, so that each form may be easily identified in practice.

The hubs A B, Fig. 473, are of the sizes shown, and are made of an alloy composed of tin one part, lead four parts, melted together. The

FIG. 472.

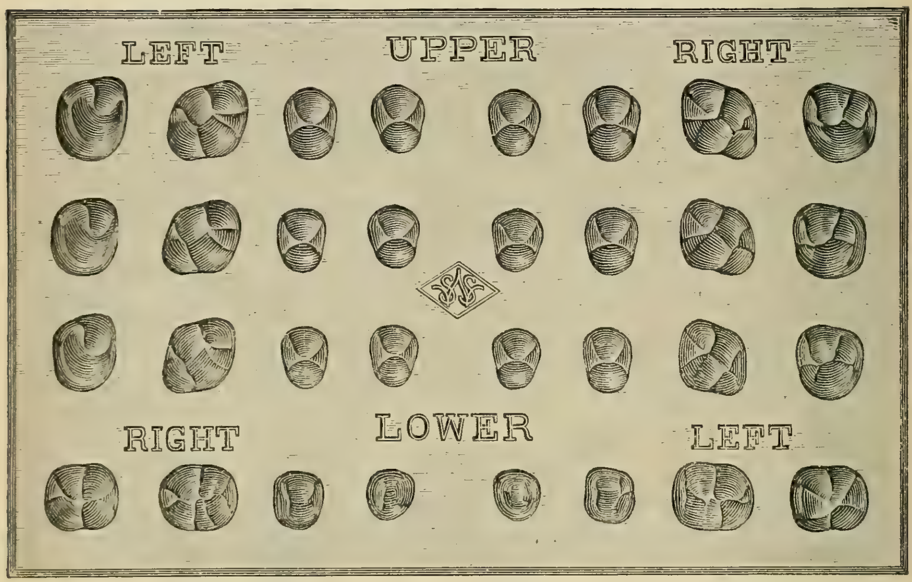
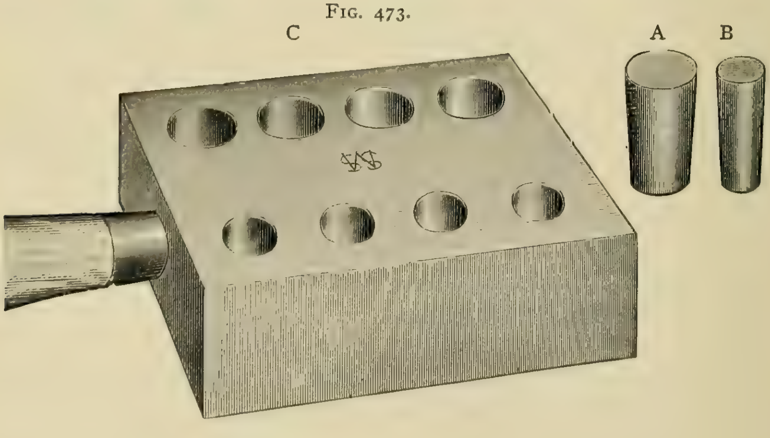


FIG. 473.

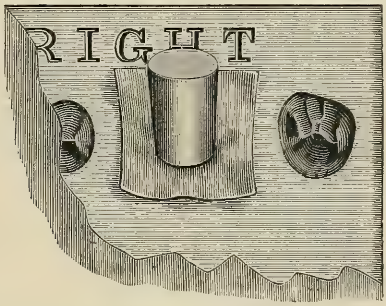


mold C should be warmed, the melted alloy poured in every hole, and the overflow wiped off just before the metal stiffens. This will

make the butts of the hubs smooth and flat. After a minute or two the mold may be reversed, the hubs shaken out, and the casting process continued until a considerable number of hubs shall have been cast.

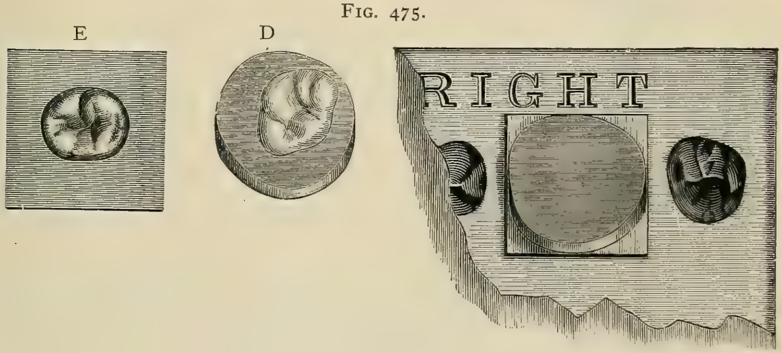
In Fig. 474 a molar hub is shown in place on a piece of No. 32

Fig. 474.



gold plate, which lies over the upper right first molar die. A succession of blows on the hub, with a four-pound smooth-faced hammer, will drive the plate into the die, and at the same time spread the hub metal from the center to its circumference in such a man-

Fig. 475.



ner that the plate will be perfectly struck up with the least possible risk of being cracked. The flattened hub is seen in Fig. 475, which also shows at D the obverse of the struck up hub, and at E the cameo of the struck up plate, having every cusp and depression sharply defined.

The counter-die plate, Fig. 472, is made of a very hard cast metal, which will admit of the striking up of many crown-plates by the means and methods described, if the crown-plates be not too thick and stiff. Of course, they should be annealed before they are placed over the die. In careful hands the die-plate should give clear cusp definitions after years of use.

The peculiar action of the hub in forming first the center of the crown-plate, and spreading from the center outward, as the hub is shortened under the hammer, until the die is overspread by the plate and hub, with the result shown in Fig. 475, is an essential feature of this process for obtaining easily and quickly the superior styles of coronal cameos shown. If a cusp or fissure should chance to crack in hubbing, a small piece of plate may be struck over it,

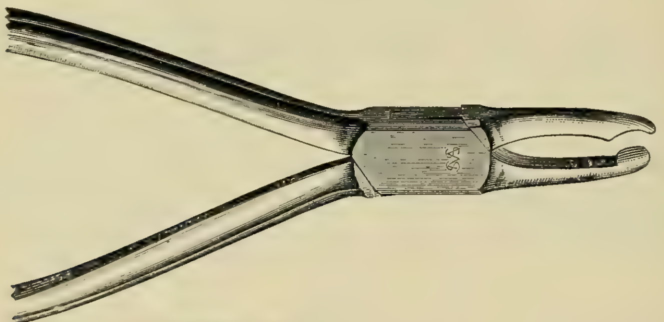


FIG. 476.

or another crown-plate be struck over the first and the two soldered together.

The depressions in the struck plate can be partly or wholly filled with scraps of plate or solder, and the surplus plate cut away from the cameo.

The fact is noteworthy that, by means of a Bunsen burner on blowpipe, these swaged cusps may even be filled with melted scraps cut from the identical plate out of which the cameo was struck. The better way, however, is to fill, say, a 22-carat cameo with 20-carat plate scraps. The fitting and soldering of the doubled or filled cameos to suitable collars is a simple matter, and need not be described.

It only remains to add the statement that, by this counter-die and hub process, gold, platinum, silver, or other metallic cap crowns,

having finely formed and solid cusps for proper occlusion and resistance to wear, can be made with little trouble and in a very short time.

After securing a well-defined occluding surface or cameo for the case in hand, it should be filled with gold plate scraps or solder of a lower carat, with a little borax. This is all held over a Bunsen burner until the small pieces of gold come to the fusing-point and settle down into the depressions of the shell. More small pieces should then be added until it is level full. The surplus gold should then be trimmed away, and a file passed several times over the surface of the solder to bring it down perfectly level and smooth. (See Figs. 477 and 478.)

FIG. 477.

FIG. 478.

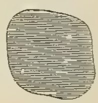
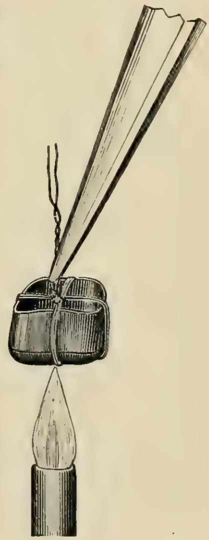


FIG. 479.



Before removing the band from its position in the mouth, a small mark should be made with an excavator to indicate the center of the buccal surface, which will serve as a guide for the correct placement of the cusps. The band should then be contoured with suitable pliers (see Fig. 476), to suit the requirements of the case in hand; a smooth surface is then given to the end which is to receive the cusps, and it will be found that an accurate joint between them can readily be secured.

Having carefully noted the line of occlusion and marked the band to indicate the point where the center of the buccal surface of the cusps or crown-plate should be placed and soldered, the two—the band and the crown-plate—should be carefully brought together and secured with a few strands of small binding wire. The joint should now be coated with borax dissolved in water, when it is ready for the final soldering. If solder has been used in filling the cusps, no additional solder will be needed at this time, as by simply holding the crown over the flame of a small Bunsen burner, as shown in Fig. 479, until the solder is seen to come to the fusing-point,

then instantly withdrawing it, the crown-plate and band will be united perfectly. If, however, gold plate has been used entirely in forming the crown-plate, a small piece of solder will be needed to unite them. The crown is then ready for the finishing processes, which consist in filing or grinding off the projecting edges of the crown-plate flush with the face of the crown, and smoothing and beveling the free edge of the band or ferrule; the crown should then be adjusted to the root and the occlusion noted. If, as is frequently the case, a little of the gold needs to be removed at one or more points, in order to have a perfect occlusion, it should be done with a small, flat-faced corundum stone. The crown should then be removed and polished at the lathe.

Gold Seamless Contour Crowns.—The manner of constructing what is known upon the market as the "Evans Gold Crowns" we here present, through the courtesy of Dr. George Evans, who says:

"The artistic requirement of all-gold crown-work is, that it shall reproduce the anatomical contour of the natural teeth. This is usually accomplished by melting solder on the collar and then trimming it to the form of the crown. A preferable method is to shape the metal forming the sides of the crown by swaging. This is easily done in a crown formed in sections, but a special process is required in the construction of seamless crowns."

A contour crown can be made by placing a seamless cap on a sectional die or mandrel of the shape of the tooth, first swaging the grinding surface on the mandrel and then stamping downward on the straight sides of the crown with a cap fitted to the shank part of the mandrel. But such a process, like many others, is too complicated to be of any use to the dental practitioner. The sectional mold method here presented is simple, practical, and general in its application.

To describe and illustrate the process, we will take one of the most difficult crowns to construct—a superior molar (Fig. 480). A natural tooth, or one made of plaster, is used as a model. From this a sectional mold is made, as illustrated in Figs. 481 and 482, in Babbitt metal, zinc, or fusible alloy. Into the mold a cap of gold (Fig. 483) 23 to 24 carats fine, 30 to 32 gage, is adjusted, fitting tightly the orifice of the closed mold. The mold is placed

in a vise, the cap expanded to the general form of the mold by hammering into it a mass of cotton, and then swaged more in detail to the form, and with a wood point or a burnisher revolved by the dental engine burnished into every part of the mold (Fig. 484). To facilitate the process, the mold should be frequently opened

FIG. 480.

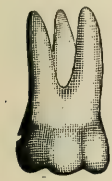


FIG. 481.

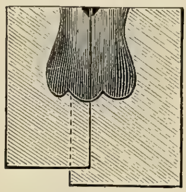
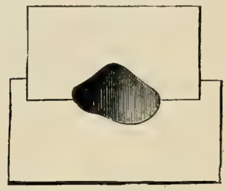


FIG. 482.



and the gold annealed. Fig. 485 represents the completed crown. These results can be secured by other styles of molds.

Another method is to form a fusible metal die of the tooth to be crowned, and, after having stamped the grinding surface of the crown, to reverse and swage the sides close to the die; the crown

FIG. 483.

FIG. 484.

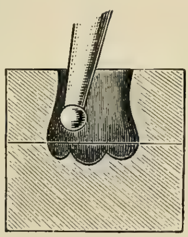


FIG. 485.

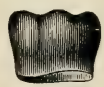
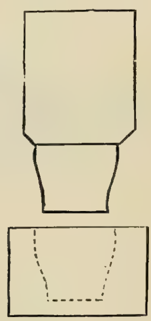


FIG. 486.



is then relieved of the core (die) by heating to the melting-point of the fusible metal and pouring it out.

For practical use a variety of molds is required, made from natural teeth of different sizes and average forms to serve in corresponding cases. The crowns can be contracted at the neck more than their size and contour call for, so that the gold will act as a tight-fitting band, which will expand to the form of the root as the crown is pressed up in the process of adjustment.

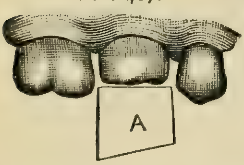
Caps of metal can be made in different sizes and kept on hand for use in this and other styles of crown-work by means of a machine, which in principle is such as is used by jewelers for forming cap-shaped pieces of gold, and in factories for making copper cartridges. The gold plate, cut into circular pieces, is pressed through a steel die-plate, with punches gaged to the holes; at each punch a small portion of the gold is turned over, thus preventing its lapping or creasing. Repeated annealing of the metal is very necessary in this process.

Methods of Contouring Crowns Constructed in Sections.—In constructing a crown in sections, the collar can be first formed on a mandrel, then placed in a mold, and burnished to the shape of the sides. The process of its adjustment to the neck of the root is then continued in the usual manner.

Another method is to stamp or burnish up the collar on a die representing the upper sections of a tooth, designated as the middle and cervical third (Fig. 486). After contouring the collar, the cap is adjusted and soldered on. With a metallic stamping plate (see page 538) these caps are quickly made.

The Selection and Adjustment of Seamless Contour Crowns.—A superior molar—one of the most difficult teeth to operate on—will serve as a typical case to illustrate this process. The crown or root is first shaped, and if necessary built down with amalgam, straight, or tapering slightly on its sides toward the occluding surface.

FIG. 487.



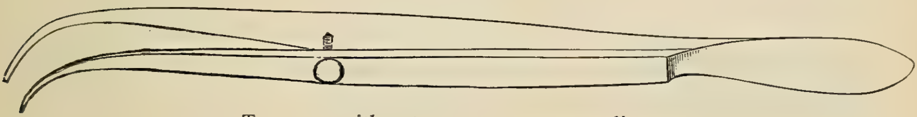
The width of the crown required from the anterior to the posterior sides of the occluding surface is first obtained by measurement with a piece of cardboard or thin copper plate, as shown at A, Fig. 487. The measurement can be taken direct from the mouth, or more conveniently from a small plaster cast made from a correct impression of the *prepared crown or root* and the two approximal teeth. This measurement can also be taken by means of tweezers with a set-screw (Fig. 488). With this measurement as a guide, the proper-sized occluding surface is readily found by comparison with the dimensions of the various crowns as shown on the printed chart of the crowns (C, Figs. 489 and 490).

The size of the neck can be calculated by the eye, or by taking

the dimensions with a piece of fine wire (Fig. 493), pressing the wire on the surface of a piece of sheet-wax, and then comparing with the impression the necks of the gold crowns.

In making a selection, it should be borne in mind that the cervix of the gold crown should preferably be smaller than larger, as it

FIG. 488.



Tweezers with set-screw to use as calipers.

can always be easily expanded, while its contraction is difficult. It is not essential that the curve of the collar shall correspond with that of the tooth, as the gold will readily take the proper shape as the crown is adjusted.

Method of Adjusting the Crown.—1. Anneal the crown se-

FIG. 489.

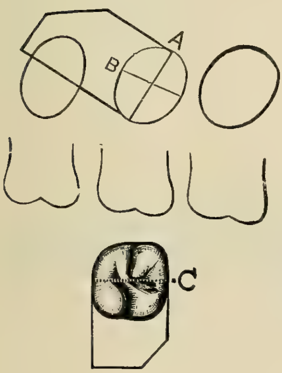


FIG. 490.

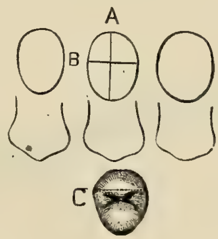
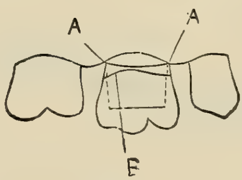


FIG. 491.



lected, and slip it over the end of the natural crown or root and gently press or work it upward—the gold of the collar will expand to the form of the root in the operation—until the edge meets the margin of the gum (A, Fig. 491).

2. Mark a line (B) on the gold parallel with the margin of the gum.

3. Remove and trim to this line (A, Fig. 494). If necessary repeat the marking and trimming until the edge meets the gum evenly.

4. Bevel the edge of the gold, readjust the crown, and press it up until the edge of the collar passes under the margin of the gum, and, if the occlusion is correct, burnish the gold to the cervix.

Fig. 492.

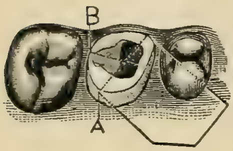


Fig. 493.

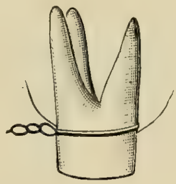
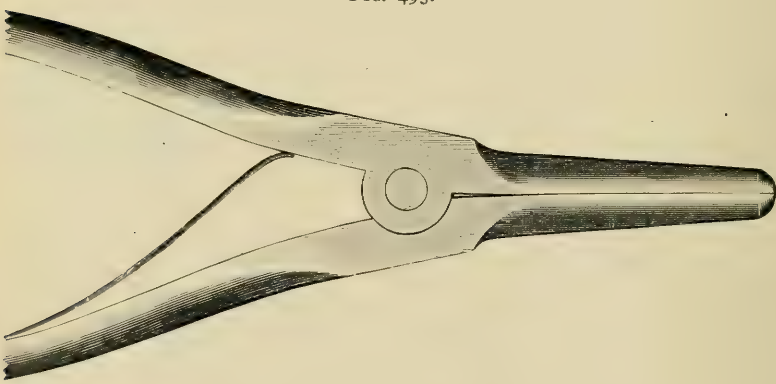


Fig. 494.

To Expand the Collar and Crown.—If the collar of the crown needs enlargement, it is easily and most properly accomplished with crown expanders shown in Fig. 495, the points of which should be introduced at first just within the edge of the neck, and the gold spread sufficiently to allow it to fit over the end of the natural crown or root, the process of expansion being gradually continued as the crown is brought into position. By proceeding in this manner too great expansion is avoided.

Fig. 495.



If the entire crown needs enlargement, it is best done by softening a mass of gutta-percha of about the same size as the crown

upon the closed ends of a pair of expanding or clamp forceps, which are heated for the purpose. The forceps points with the gutta-percha are then introduced inside the collar of the crown, which should be moistened to prevent adhesion. The gutta-percha is next withdrawn, hardened in cold water, and cut through the center between the points of the forceps. This makes practically an expanding sectional mandrel with which the crown can be enlarged according to the position in which the forceps were introduced (Fig. 496).

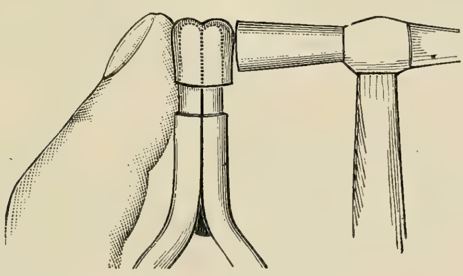
FIG. 496.

To expand the crown without enlarging the neck, trim off the gutta-percha on the forceps at the neck.

The naked points of an ordinary lamp forceps can sometimes be used to advantage in expanding a portion of the coronal section of the crown.

To Alter a Side.—The contour of one or both sides can be depressed and the crown thus narrowed by introducing the points of a crown expander or some tool that will fit loosely inside the crown, then steadying the crown with the fingers, as shown in Fig. 393, and tapping the sides to be reduced with the flat end of a riveting hammer. This is necessary when the *contour* or *the side* of

FIG. 497.



a crown *presses on an adjoining tooth,* and the crown is thus prevented from coming in proper position.

To Alter the Shape of a Portion of the Collar or Side of a Crown.—Slip the crown over the point of an anvil, the end of a pair of expanders, or a small round-handled instrument held in a vise; then tap the part to be altered with the flat end of a riveting hammer to the form desired.

To Alter the Occluding Surface.—Before the crown is pressed

up to its apparently proper position, the occlusion should be examined, and calculations carefully made to obviate any defects of articulation, which can be readily corrected at this stage by proper manipulation of the crown. Any necessary change in the form of the occluding surface can be made with the crown in position on the tooth, by means of an instrument tapped by the mallet; by removing the crown, placing it over the closed points of an expander, and tapping and burnishing the part; or by holding the crown between the thumb and forefinger with the edge of the collar resting on the side of the next finger, which when necessary can be protected with a napkin, and then tapping the gold with the point of a riveting hammer (Fig. 498).

The occluding of the antagonizing teeth on the crown by the patient will assist and complete the process of articulation.

FIG. 498.

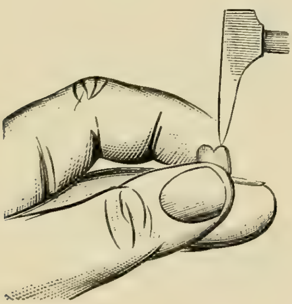
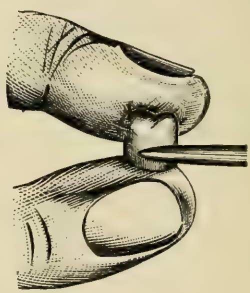


FIG. 499.



To Contract the Neck.—Slightly bend in the edge of the gold at the neck with narrow-beaked pliers, and, holding the crown evenly and firmly between the fingers, as shown in Fig. 499, burnish the sides of the neck section inward around the entire circumference of the crown.

To Considerably Contract a Crown.—Slit the gold longitudinally at the palatal side, nearly its full length to the grinding surface, bevel off the edge to lap under, contract the crown, readjust to the tooth, remove, place the smallest quantity of dampened fluxed solder filings in the seam *on the inside of the crown only*, and solder by holding in an alcohol flame. Then proceed with the further adjustment of the crown.

The outside line of the seam can be stoned off and polished after

the crown has been fitted, and additionally soldered to strengthen the sides or grinding surface.

Strengthening Seamless Gold Contour Crowns.—Additional strength and stiffness can be given to seamless gold crowns, when desired, in several ways. The liability of melting the gold which forms the sides of the crown in the operation has, with some, been the principal objection to their use. This, however, can be avoided.

When the crown has been properly adjusted, dampen the inner surface with a piece of wet cotton on the point of an instrument; place in the interior a quantity of fluxed solder filings (solder filings mixed with Parr's flux or pulverized vitrified borax); place the finger over the open end of the crown, invert, and shake well. A portion of the solder filings will adhere evenly all over the wet surface. The surplus is allowed to drop out by removing the finger. Then gradually and uniformly heat the crown by holding it with tweezers in an *alcohol flame* (not gas) until the solder fuses, when it will flow evenly over the surface of the gold without materially altering the general form. The crown should be held in such a position that a full view of the interior is presented and the melting of the solder rendered visible, which will occur at a red heat.

An extra quantity of the solder filings can be placed in the interior of the cusps with a spoon-shaped excavator to additionally fill or strengthen them if found necessary.

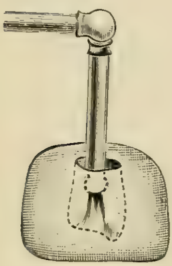
When a *Bunsen gas flame* is used instead of an alcohol flame, the grinding surface and sides of the crown should be first coated with whiting. This is easily done by dipping the crown into a cream-like mixture of whiting just before inserting it in the flame. The moisture in the whiting should be first slowly evaporated by heating up gradually. Great care must be exercised in the use of a gas flame to avoid melting the crown. The crown should be watched, and instantly removed as soon as the solder fuses and flows.

If too much solder has been applied at any point, it can be trimmed and smoothed with corundum melted on to an old engine bur point. Always boil the crown in acid to remove the flux. The removal of flux from the inner surface of the crown is absolutely necessary if you intend to use it in bridge-work, as solder will have to be melted on the outside.

To Repair a Gold Crown.—When a hole is cut or melted in

any kind of a gold crown, place a piece of soft wax in the aperture on the outside of the crown, adapt on the inside close against the gold a piece of platinum foil, somewhat larger than the aperture, so that it will adhere to the wax. Fill the interior of the crown with investing material, and flow a little solder over the surface of the platinum and gold on the outside of the crown.

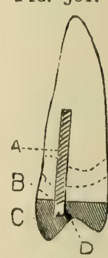
Fig. 500.



Gold seamless crowns can also be strengthened or filled with solder, or even 18- or 20-carat gold plate, by investing the outside surface in plaster and marble-dust (Fig. 500), and then with a small flame of the carbo-oxyhydrogen blowpipe, not over ½ of an inch in length, introduced inside of the crown, melt and flow the solder or gold plate over any portion or even all of the surface of the gold. The crown, if formed of gold with a thin lining of platinum, can be soldered by either method with little danger of being melted.

Supporting the Crown.—In crowning teeth with living pulps there is sufficient of the natural crown present to afford a secure foundation and attachment for the artificial crown, as is also the case with many teeth that are pulpless; but in badly broken-down crowns, or where only the root is present, a metallic pin or post should be inserted in the root, and the part built down with amalgam to a form which will afford secure support and attachment to the artificial crown and facilitate its adjustment.

Fig. 501.



In many cases the required support for the crown can be secured by means of a screw (Fig. 501). A How screw or a post of silver wire is inserted in the root canal A. Amalgam is then packed in the lower section of the artificial crown C to the line B, and the screw is pressed into the amalgam. Amalgam which has been put in a piece of chamois and the mercury pressed out with a pair of pliers until it is in the condition termed "dry" will adhere to the gold without affecting it. The amalgam is first placed in the crown slightly in excess of the amount required, and the crown adjusted, removed, and the surplus scraped out. This process is continued until the screw or the crown section of the natural tooth forms an indentation in the

amalgam, which it will fit when the crown is cemented on. The vent for the escape of air and surplus cement—which should always be put in perfect-fitting crowns and afterward filled with gold or amalgam—should be in the line of the indentation in the amalgam, with which it must connect (D).

These crowns can be inserted in an easy and inexpensive manner by filling in the lower section of the crown with amalgam instead of gold, and allowing the head of the screw or the natural crown to indent the amalgam as above described, and then cementing on the crown with oxyphosphate in the usual manner.

In a case so inserted, with no antagonizing teeth, the result is the same as though the inside of the occluding surface of the crown was filled with gold; but if antagonizing teeth are present, the gold of the crown is apt to wear through in places and expose the amalgam.

To Securely Attach a Crown.—If the tooth is short, and the occlusion of a character requiring the reduction of the collar to such a degree as to suggest insecurity when the crown is cemented, a barbed or headed pin, which will anchor in the natural crown or root, should be soldered in the center of the gold crown. This is done by passing the pin through a hole drilled in the occluding surface of the crown, which is then adjusted in the mouth, removed, invested, and the pin soldered from the outside. If the pin is tapered and fitted tightly to the hole, the soldering can be accomplished without investing, by holding the crown and pin with solder in position in an alcohol flame.

To Alter a Gold Crown to the Exact Form of any Corresponding Natural One.—In a case having nearly all the natural teeth present, in which the occluding surface and sides differ in shape from the form of the gold crown, to such an extent as to interfere with its adjustment, a die of the natural crown should be made of fusible metal (Melotte's fusible alloy), and with it the interior of the gold crown should be altered in shape sufficiently to receive the natural crown, by resting the occluding surface of the gold crown on a folded napkin and gently tapping the die into it.

The advantages of seamless contour crowns are, that they represent perfectly the tooth in its anatomical contour, present a uniform surface of pure gold, which preserves its color without tarnishing, and are quickly and easily adjusted. Their defects are inability to meet the requirements of abnormally-shaped roots and anomalous articulations.

CHAPTER XXXI.

BRIDGE DENTURES.

To the skilled dentist, well versed in crown-work, bridge-work does not present any great difficulty, inasmuch as crowns are the beginning and the end; it is practically continuous crown-work, though many of the crowns—those filling or bridging the space where the roots have been removed—have neither collars nor posts. In constructing these teeth, the matter of cleanliness should especially be considered; where it is admissible to allow them to come in contact with the gum tissue (as in the anterior part of the mouth), only the cervical porcelain tips should touch. The metallic backing and solder should recede, leaving self-cleansing spaces.

Some diversity of opinion exists, however, as to the advisability of permanently fixing such appliances in the mouth. Prominent among the objections urged is, that, in the event of accident to the porcelain facing of the crown, there is no sufficient remedy without detaching the entire piece, of which the teeth are a part. It is further objected that a stationary fixture of this kind in the mouth must become not only offensive from the accumulation and retention of oral debris incapable of adequate dislodgment, but a source of injury to the remaining natural teeth, which necessarily follows the prolonged retention of alimentary substances exposed to conditions so favorable to fermentation and putrefactive decomposition.

On the other hand, the writer entirely agrees with many competent, intelligent, and conscientious operators, who, from observation and experience, are qualified to form a just estimate of the merits or demerits of bridge dentures, and who bear testimony in unqualified commendation of its superior excellence *when skilfully performed under conditions that justify the operation,* and claim for it as complete exemption from the alleged objections as is obtained in the use of any other mode of replacement in similar cases.

In fact, herein, we think, lies the secret of either success or

failure in connection with bridge dentures, for it is in the construction of this class of dentures, more than any other, that unusual mechanical skill is required, and professional judgment needed for determining *where* they are admissible.

Limitations.—For the support of bridge dentures, strong, healthy roots are required, and the width of the space to be spanned must be governed by the size and strength of these points of anchorage. Whether a full upper or lower denture can be supported by four points of attachment depends upon the relative smallness of the jaw, the size and strength of the roots and teeth, and the occlusion, the operator always being governed by the exact condition of individual cases.

Before entering upon a more general consideration of the subject, it may be helpful to give a few reflections or suggestions in the way of typical cases, as follows:

One strong central root will support two teeth, that is, the crown and either the adjoining central or lateral. Two central roots will support the four incisors. Two strong cuspid roots alone, or with the aid of a central root, will support the six anterior teeth. A cuspid root and a strong, healthy second or third molar on the same side will support the intervening teeth. One molar or bicuspid on one side, and a bicuspid or molar on the other, with one or two central roots, will support a bridge between them. One right and one left molar, with the assistance of the two cuspid roots, when the conditions are favorable, as spoken of above, will support a bridge comprising the entire arch.

It should be remembered that the preparation of the teeth and roots for the support of a bridge is the same as in ordinary crown-work, except that the trimming of the sides and the drilling of the root canals should be, as far as possible, *in parallel lines*, so that in the adjustment of the finished piece the crowns will move readily to their places.

STATIONARY BRIDGE DENTURES.

Among the simpler forms of substitution which may be properly classed under the head of "bridge-work," is the one in which a single artificial crown derives support from attachments made to one or more of the adjoining natural teeth, originally by a process of cavity filling. The original conception and practical application

of such a method of supplying an edentulous space is attributed to Dr. B. J. Bing, of Paris, France, whose method of operating has since been greatly modified.

Dr. Webb's Method.—One of the earlier experimenters in this mode of replacement was the late Dr. Marshall H. Webb, who thus describes his method of operating in these cases:

"The insertion of a crown without plate or clasps, where no root remains, is a difficult operation, but when well performed, and the crown attached to teeth that are firm in their sockets, it is both satisfactory and permanent.

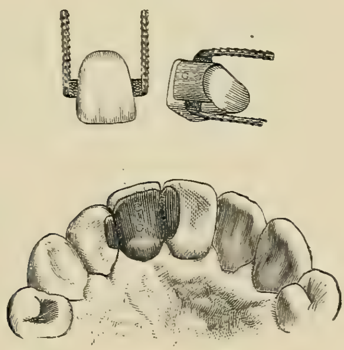
"The first such operation performed by the writer was completed February 12, 1873, and the crown now remains as firm as when inserted. The operation was performed in the following manner: After suitably forming the cavities in the proximate wall of each tooth next the space left by the loss of the one that had been extracted (unnecessarily) some years before, an impression of the parts was taken, and a plain porcelain crown was selected, fitted to place, and backed with gold plate (18 carat). A portion of the backing extended about 1½ lines from each side of the crown for insertion in the cavities prepared in the adjoining teeth, and to these parts a gold wire was soldered to fit into the pulp chamber of the central and lateral incisors. A small gold plate was then formed to fit upon the gum, covering as much space as was taken up by the neck of the natural tooth. The backing was riveted to the pins in the porcelain, and this placed in position, and while the whole rested on the small plate upon the gum, the backing and plate were so secured by wax that they could be removed intact, and, after being placed in a matrix, soldered. Each extended side of the backing and the surface of the wire was barbed with an engraver's bossing tool, so that the gold-foil would the better secure the crown when filled into every part.

"The porcelain, with the gold attachments, being ready for insertion, a piece of light, medium rubber dam was put in place on two teeth each side of the space to be filled, and over the gum upon which the crown was to rest. (The rubber takes up but little space, and this is more than compensated for, when the ligature—waxed floss-silk—is pressed to or near the neck of each adjoining tooth.) Oxychlorid of zinc was then placed in the pulp chamber of the central incisors and the crown at once pressed to

place. When the cement had hardened sufficiently to safely admit of further progress in the work, a portion of it was cut away from around the wire so as to make proper anchorage for the gold. Small pieces of light cohesive gold-foil were then impacted around part of the wire and that portion of the plate extending into the cavities, and the crown was thus secured. The porcelain and gold attachments as prepared for insertion, and the crown in position, are illustrated in Fig. 502.

"The cavity in the central incisor was extended to the cutting edge of the tooth, that access might be had to the wire and both sides of the plate; foil could not otherwise have been put in place, unless a portion of the labial margin of enamel were cut away, and this would have been objectionable because of the exposure of gold.

FIG. 502.



A small part of the labial instead of the cutting edge of the enamel of the lateral was removed, for the reason that there is not such a body of tissue as to safely allow it to be cut away to the same extent as in a central incisor. The margin of enamel was so formed, and the foil so inserted and finished, however, that, though the gold can be seen, it is not conspicuous.

"While the operation just described has thus far proved successful, yet there is a possibility of the porcelain being broken from the platinum pins which hold it to the gold plate. To avoid such an accident, a groove should be cut on each side, and along the cutting edge of the porcelain (Fig. 503, *b*), that gold-foil may be impacted into it, after a heavy backing of gold plate and the wire have been fixed in place and soldered. When the groove has been cut in the

porcelain with a fine-edged corundum disc, one with an edge of the diameter of the gold wire selected for the case should be used to make a groove across the porcelain between the pins (Fig. 503, *a*), into which the wire to connect the artificial crown with the natural teeth is to be placed (Fig. 503, *b*), either beneath the plate, or so that the edges of the latter may be joined to it, as the necessities of the case may require.

"A starting-point should be made either between the gold backing and porcelain, or between this and the wire, and the latter firmly fixed in a hand-vise while the gold-foil is being impacted with the electromagnetic mallet. When the gold is properly and solidly placed in the groove and over the backing and wire, it not only aids in securing the porcelain, but the contour of the crown

FIG. 503.

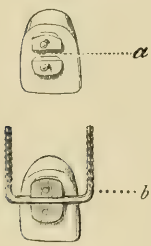
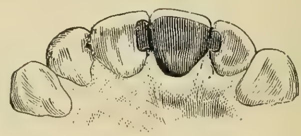


FIG. 504.



can be nicely filled out, and the operation made durable and beautiful (Fig. 504).

"The surface of the gold placed along the base of the crown to the edge of the porcelain, and which is to rest against the gum, together with the palatal portion, ought to be properly formed and finished before the crown is put in place, and this should be done in the manner before described. There should be a little space between the wire and cervical wall in each tooth to which the crown is to be attached, and narrow pieces of light gold-foil carefully placed in this part, between the wire and enamel, with small curved instruments and the aid of the mallet; the surface of the gold at this part at least should be smoothly finished with very narrow ($\frac{1}{16}$ of an inch) strips of fine emery cloth before the rubber dam is removed.

"One of the most satisfactory operations the writer ever performed was the insertion of a crown where a cuspid root had been

extracted (unnecessarily), and the lady subjected to the wearing of a gold plate for some time. This crown was prepared and the contour filled out with foil as described and as illustrated in Fig. 504, but gold wire, No. 13, was attached to and built in with the porcelain, placed into the pulp chamber of the adjoining lateral incisor (which had been filled), and this same wire extended from the anterior to near the posterior proximate surface of the first bicuspid tooth, the pulp of which remained in normal condition. The crown was placed in position with oxychlorid of zinc, and cohesive gold-foil was then impacted with the electromagnetic mallet around a portion of the wire in the root and into the cavity in the crown of the incisor, also into the cavity in each proximate wall of the bicuspid tooth, as well as around and over the wire, joining the two fillings through the enlarged fissure.

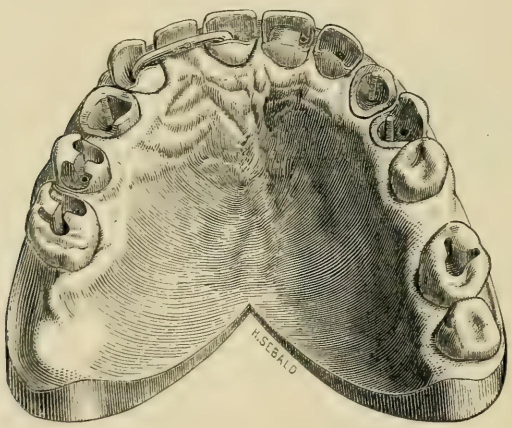
"An extensive operation of attaching a crown to adjoining teeth was performed by the writer before the Pennsylvania State Dental Society, in July, 1879. In this case disintegration had taken place in many of the teeth, and cavities of decay had been prepared and filled from time to time. The teeth were abraded and the dentine was exposed along the entire cutting edge of each tooth that occluded with another. The right upper lateral incisor had been lost twelve years before. The crown of the left cuspid tooth was missing, and but a small portion of the enamel and dentine of the first bicuspid upon either side remained. These last were, of course, pulpless, as also were the right cuspid and central and left lateral incisor teeth, and the pulp chamber of each of these had been filled. All the operations were performed previous to the insertion of the crown in the space left by the loss of the lateral incisor, and, as this crown and each cavity and pulp chamber was prepared for the gold, all appeared as here illustrated (Fig. 505).*

"Gold wire (No. 13), with a sharp thread cut upon it, was screwed into the dentine, and, at the same time, all the interstices between the tissue and the gold were filled with oxychlorid of zinc. When crystallization had taken place, some of the cement and dentine was removed from around the wire with a small bur, and a groove was cut in the dentine near the margin of the root so as to

* The cut (Fig. 505) illustrates the case well, though there are parts and grooves in which to anchor the gold that are not distinctly shown.—M. H. W.

secure proper and sufficient anchorage for gold; cohesive foil (principally No. 30) was impacted into these parts, and the entire contour of the crown was restored with the electromagnetic mallet. This crown was not faced with porcelain, because the teeth of the gentleman for whom these operations were performed are but slightly exposed to view; and then, too, the gold had to be placed over the enamel to support and protect it along the cutting edges of all the incisor, the cuspid, and bicuspid teeth. A gold screw was placed in the pulp chamber and extended into the crown of each bicuspid tooth (Fig. 505). The apical foramen of each pulpless tooth was closed, and the whole of each pulp chamber into

FIG. 505.

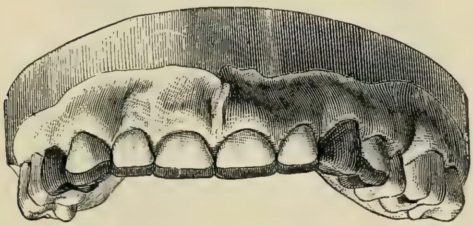


which a wire was not placed was filled with gold. With a properly adjusted electromagnetic mallet, carefully guided, and operated with a full current of electricity from a freshly charged four-cell Bunsen battery, the contour of each crown was restored with gold, made solid and perfect throughout; the foil was placed in the same manner over the finely prepared margins of enamel, which were not marred in the least (Fig. 506).

"The lower incisor teeth had so changed after the loss of the upper lateral that they almost closed upon the gum. This was partly owing to the abrasion of the remaining teeth, and in part due to the lower incisors gradually rising in the alveolar process. Because of such occlusions of the teeth a porcelain crown (plain

'plate tooth') with 'cross-pins' was used, and fitted and soldered to the gold wire, there being no space for a backing of plate. When the wire was prepared, the porcelain grooved and fitted to it, and ready for the placing on of the gold-foil, the whole appeared as illustrated (Fig. 505), the wire extending into each adjoining root about four lines. The cutting edge of the porcelain was removed to the same extent as that of the abraded and prepared incisors, so as to present the same appearance and have the gold support and protect the remaining part. The wire of the crown was held in a hand-vise, while cohesive gold-foil was placed solidly in the grooves, around the wire, over the cutting edge of the porcelain, and the entire contour restored with the electromagnetic mallet. During the final fitting of the crown, it was made to so rest against the gum that the blood was pressed from the capillaries of the part. When

FIG. 506.



ready for insertion, a medium rubber dam was applied to two teeth each side of and across the space which was to receive the crown; small barbs were made all around the wire with a sharp knife, and oxychlorid of zinc was then placed in the pulp chamber of the central incisor and cuspid, and the crown at once pressed to place. After it had been in position an hour, to allow of complete crystallization of the cement, portions of this and of the dentine were removed with a small bur so as to better secure the crown and obtain anchorage for the gold-foil then to be put in place around the wire, into each cavity, and over the prepared margins of the enamel. Principally No. 30 gold (1/4 of an ounce cohesive foil) was used in this case, and all was impacted with the electromagnetic mallet, except a few pieces of light foil placed in the space between the wire and cervical wall, and even these pieces were gone over with this very valuable instrument after they were in place. With this

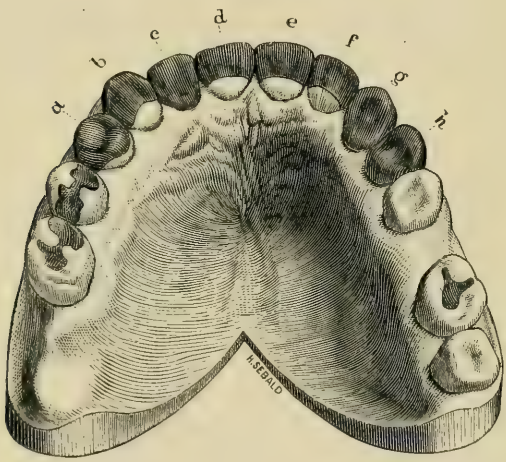
and all the operations completed, the case appears as illustrated in Figs. 506 and 507.

"All those who have the ability and who will work earnestly and conscientiously to properly perform the various operations described, and do their very best in every case, can so manage their practice as not to make it necessary for any of the patients they have charge of to wear artificial teeth mounted upon plates."

Dr. Webb's method of operating in these cases was, to some extent, subsequently modified as follows:

"The method, modified and followed by the writer since per-

FIG. 507.



a, b, d, f, g, and *h.* Pulpless teeth. *g.* Whole crown restored with gold. *a, f,* and *h.* Almost entire gold crowns. The teeth, *b* and *d,* support the gold crown faced with porcelain, *c,* and fully one-fourth of the crown of each of these is restored with gold, as is also that of *e,* the pulp of which is living.

forming his first operation, is quite different from the mode adopted in inserting the first crown, which was prepared somewhat according to Dr. Bing's plan, and, though the work is more difficult, yet the improved crown is stronger and more complete, cleanly, and beautiful than when gold plate is simply riveted and soldered to the porcelain. It was to avoid such an accident as the breaking of the porcelain from the pins that the writer modified the method of preparing and inserting crowns. Among the changes made were those of making a groove (though not cutting it too deeply) in

each side and along the cutting edge of the porcelain, and placing gold-foil solidly in the groove and slightly over the cutting edge, to make the porcelain more secure than when the platinum pins alone hold it, and to protect the edge from the occlusion of the lower teeth; also, to build the crown into the approximal surfaces only. After the wire has been fitted to the adjoining tooth or teeth, or properly placed in a root, and a heavy but rather narrow backing of gold plate has been riveted to the porcelain, and the parts are fixed together and soldered, the greater part of the preparation of a crown which remains to be made, and the whole of the building of gold-foil about it, is done out of the mouth at whatever time may best suit the operator; but the work requires care, and must be skilfully and well done. A starting-point should be made either between the gold backing and porcelain or between this and the wire, and the latter must be firmly fixed in a hand-vise while the gold-foil is being put in place and made compact with the electro-magnetic mallet. All crowns should be prepared and finished in the manner described, with such change or additional work as is necessary to place them on roots, or to attach them to single or to the two adjoining teeth where roots are missing.

"Methods have been devised or adopted with the object of lessening the time necessary to perform such operations, and making them easy and cheap, by the use of amalgam or some other plastic material; but sufficient time must be taken, excellent judgment and ability are required, and the use of gold is necessary for the doing of really fine, beautiful, and permanent work.

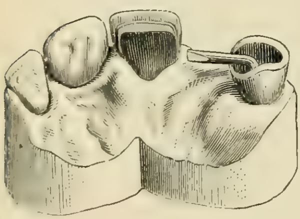
"When a crown is to be attached to one tooth alone, the operation is not likely to be successful (excepting where a bicuspid crown is built into a molar tooth), unless the tooth which is to support the crown be a pulpless one, and then such an operation can be made both durable and beautiful. To secure sufficient anchorage for the insertion of a crown in such a manner, therefore, it may sometimes be necessary to destroy a pulp; but this ought to be the last resort, and should be done only when calcification of the enamel and dentine is complete or apparently so. The end, if well attained, justifies the destruction of a pulp for the insertion of a crown, mainly because of the beneficial results which follow.

"Where a crown is to be built on to one tooth only, a gold wire no lighter than No. 12 should be used. It should be fitted as far

up the root as it is safe to enlarge the pulp chamber for it; but the drilling may be properly done only after every part of the pulp has been removed and the apical foramen has been carefully closed with small, narrow pieces of light gold-foil, which must not be put in place so long as there is any irritation about the end of the root.

"In the case here illustrated (Fig. 508), the wire is fitted in the root and bent to receive the crown, and the cavity is prepared for the filling in of gold. The cuspid, as well as the other teeth remaining in the mouth, became so abraded as to expose the dentine, so that the margins of enamel had to be prepared for the placing of gold over them, and when the crown was built in place, they were carefully covered with and are thus protected by the solid metal. After the porcelain part of the crown of the lateral incisor had been fitted to the model and soldered to the wire—this portion of the wire should be flattened somewhat in some cases—the groove was made around the porcelain; the foil was solidly built in place, and finished in the manner hereinbefore described; the crown was then inserted, and the contour of the cuspid tooth was restored with gold. The root of the left central incisor remains, and the crown which is fitted upon it is prepared for the building on of gold-foil; after which it will be ready for insertion. When this crown is put in place, the gold wire is to be surrounded with gutta-percha; but little of which is, or should be, needed in the pulp chamber, because of the close fitting of the wire in, and of the crown upon, the root. During this preparation, a plain pivot crown is kept upon the root, held by wood and gutta-percha.

Fig. 508.



"When the lateral incisor crown, in the case illustrated, was ready for insertion, and the gold at the base, which was to rest upon the gum, had been nicely fitted to it, and the whole of the gold was smoothly finished, a good-sized piece of medium rubber dam was applied to the teeth (the cuspid and the central and lateral incisors) on each side of the space to be filled, and arranged so as to cover the gum and the root between these teeth. The crown was made to so rest upon the gum as to press the blood

from the capillaries of the part, and thus prevent particles of food from getting under it. (While the thickness of the rubber dam might, to some extent, prevent the placing of such a crown against the gum as firmly as it should be pressed, yet this thickness is compensated for by the pressing up of the gum when the floss-silk ligatures are placed about the neck of each adjoining tooth.) After all this had been done, and fine barbs were cut around the gold wire with a sharp knife-blade, oxychlorid of zinc was placed in the pulp chamber of the cuspid tooth, and, while the cement was still plastic, the crown was at once pressed into place, and held there for a few moments.

"After the cement had hardened sufficiently to safely admit of it, it was cut away from around the wire at such parts as would make proper anchorage for the gold. There was, and in every case should be, a little space left between the wire and cervical wall to be filled with gold for the protection of the enamel at this part. Narrow pieces of light cohesive foil were first placed in this space with small, suitably curved instruments, and afterward solidified with the mallet; after which a little larger, though still narrow, and heavier (none over No. 32) pieces of folded foil were used for placing around and about the wire in the root, filling the cavity, restoring the contour, covering and protecting the prepared margins of the enamel, each piece of the gold being thoroughly cohesive and made compact with the electromagnetic mallet. The surface of the gold placed around the wire between it and the cervical wall, as well as all that part near the gum, was smoothly finished with small files and very narrow ($\frac{1}{16}$ of an inch wide) strips of emery cloth before the removal of the rubber dam; after which the remainder of the gold was made smooth and so trimmed down as to be sure of the proper occlusion of the teeth. The crown attached to the cuspid tooth was made just short enough to be free from the striking of the lower teeth. The operation was finished at another time with Hindustan stones, together with pumice upon fine wood made into suitable shape.

"When a crown can be securely attached to one instead of two teeth, the time of building-in is lessened about one-half. The slight movement which takes place in the socket of the tooth supporting the crown is not so interfered with as when two teeth are fixed together by the gold wire holding the porcelain. If it

should afterward become necessary to perform operations upon the adjoining teeth, the rubber dam can as readily be applied as before attaching the crown."

Dr. Darby's Method.—Professor E. T. Darby, in commenting on the method just described, says: "Dr. B. J. Bing was the first to call my attention to a method of building one tooth into the adjoining teeth by means of gold wires running from the artificial into the natural teeth. I have never seen any of Dr. Bing's operations, but Dr. Marshall H. Webb has called my attention to one or more in the mouths of his patients, which have done good service for years. I also have in my own practice several of which have proved most satisfactory.

"The cuts, Figs. 509 and 510, represent two cases where arti-

FIG. 509.

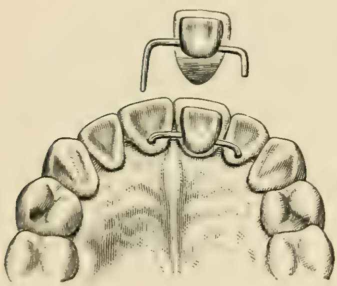
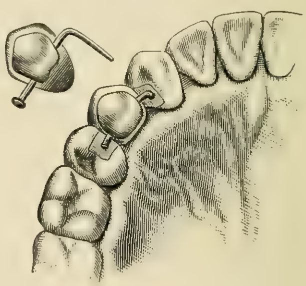


FIG. 510.



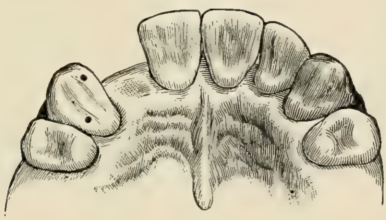
ficial crowns have received their support from the adjoining teeth. It is desirable to have a pulpless tooth for a neighbor, though I question if one would be justified in devitalizing a pulp to secure this end. In the cases presented, a piece of gold wire was soldered to the backing of the porcelain tooth, and allowed to extend well up the pulp canal of one of the adjoining teeth. After it had been nicely fitted to its place, the rubber dam was applied and drawn tightly over the gum between the two natural teeth; the canal of the devitalized tooth was then filled with oxychlorid of zinc and the tooth, with its gold support, pressed into position. When the cement had hardened, the bulk of it was cut out and the space filled thoroughly with gold. The other end of the bar was packed around with gold-foil, and the cavity of decay or cavity of convenience was filled in the ordinary way.

"It is always better to take an impression of the space and adjoining teeth at the outset, and then do the major part of the work in the laboratory. The gold wire which enters the root can be bent or shaped with the pliers when the crown is adjusted for final insertion.

"I would not be understood as saying that these operations can only be performed successfully where there is a devitalized tooth for a neighbor; on the contrary, I have seen teeth inserted in this way where both teeth were living, but the support which is to be derived from the long right angle of gold in the root is certainly a great security against accident, adding, as it must, much strength to the operation."

The Plate and Pin Bridge.—Professor Wilbur F. Litch has greatly improved and simplified the method of attaching a single

FIG. 511.



crown to the adjoining teeth in the class of cases under consideration. The following is his description of the process:

"Fig. 511 represents a typical case, in which a lateral incisor (crown and root) has been lost, the cuspid and front incisor, fully vitalized and without approximal carious cavities, remaining in position.

"1. Take in plaster an accurate impression of the cuspid and incisor and the interspace. From this obtain a plaster model of the parts.

"2. Make from pure gold, rolled to the thinness of 26, standard gage, base-plates, to be carefully adjusted to the palato-approximal surfaces of the cuspid and incisor. These can be made by swaging on dies and counter-dies obtained from the model, but more conveniently by bending the gold into shape upon the plaster model and pressing and burnishing it into perfect adaptation upon the natural teeth.

"3. Select a plain plate porcelain tooth of suitable length, shape, and shade, and wide enough to fit easily into the interspace. Let the neck of the tooth rest lightly upon the gum.

"4. With pure gold or platinum make a backing for the porcelain tooth.

"5. Place the tooth thus prepared and the base-plates already made upon the cast, and accurately adjust the approximal edges of the base-plates to the backing of the porcelain tooth *in situ* upon the cast.

"6. When this adjustment is made, cement together the base-plates and backing with a brittle, resinous cement (resin, two parts; wax, one part; or sealing-wax will answer), and before the cement has fully hardened remove from the cast to position in the mouth, perfecting the final adjustment there. By this method much greater accuracy of adaptation is obtained, as the lines of length, width, and contour are too fine to be reproduced with absolute fidelity in a plaster model. In this part of the process too much care cannot be taken to have each piece of the appliance fitted with absolute accuracy to the surface for which it is designed. When this has been accomplished, throw upon the yet more or less plastic cement a stream of ice-cold water from an office syringe; this renders the cement perfectly brittle and incapable of bending. Immediately remove from the mouth and invest in a mixture of equal parts of marble-dust and plaster-of-Paris.

"7. After the investment has firmly set, solder the base-plates to the backing, and the backing to the platinum pins of the porcelain tooth, using as a solder 20-carat gold. Thus joined, the appliance will present the appearance shown in Fig. 515. A representing the base-plate for the cuspid; B, the base-plate for the incisor; C, the porcelain tooth with its platinum backing; D, the points of union between the base-plates and backing. At these points the greatest strength is required, and it is important that here a large amount of the solder should be placed. The porcelain tooth being usually thinner than the natural teeth, there is nearly always an angle or depression at the points indicated, in which the thickness of the gold can be considerably increased without interfering with occlusion.

"8. For the purpose of attaching the denture as thus far constructed, drill a small cylindrical opening through the palatal sur-

face of the enamel of the cuspid and incisor respectively. These openings should usually be placed about as indicated in Fig. 514, at C, D. Sometimes, owing to a close occlusion, or to the contour of the tooth, it is desirable that they should be located a trifle nearer the neck of the tooth. Each opening should be well undercut, but must not encroach upon the dentine far enough to endanger the pulp. In size the openings need not be larger than will admit a platinum pinhead, in diameter corresponding to 13, standard gage, with a shank of 18, standard gage. Into each of these openings must be fitted a platinum pin of the size indicated. The head of each pin must be made thin and perfectly flat both upon its upper and under surfaces.

" 9. In each of the base-plates make an opening corresponding in position to those in the natural teeth. Pass through these openings and cement in them the free ends of the platinum pins.

FIG. 512.

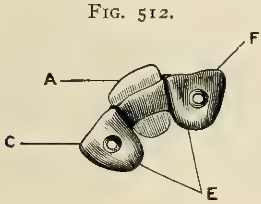


FIG. 513.

While the cement is yet plastic, place the denture in position in the mouth, carefully pressing the pinheads into the openings made for them and burnishing the base-plates into perfect contact with the palatal surfaces of the teeth; chill the cement, remove and invest as before, and with 20-carat gold solder the pins to the base-plates, flowing upon them and the backing as much of the solder as may be necessary to give them the desired thickness and rigidity; the amount admissible largely depending upon the nature of the occlusion, a central thickness of about 21, standard gage, being all that is really requisite for strength, while the edges can be made much thinner.

" Fig. 512 represents the appliance without the pin. A is the porcelain tooth and backing; E, the base-plates; C and F, the openings for the pins.

" Fig. 513 represents the appliance completed, with the pins in position.

"Fig. 514 represents the natural teeth and interspace B, with openings for retaining pins, C, D.

"Fig. 515, already described, represents the appearance presented when the bridge is cemented in position.

"*To Attach the Bridge.*—To attach the bridge the best attainable oxyphosphate cement should be used. It is desirable that it should set slowly. Thoroughly dry the teeth and denture; mix the cement to as thick a consistency as is compatible with perfect plasticity. A thick, viscid, semi-fluid mass is what is required. With suitable instruments, swiftly but carefully place the cement around the head and shank of each platinum pin, and also in the openings in the natural teeth. This care is necessary in order to exclude all the air-bubbles and thoroughly engage the pinheads in the cement. They furnish ample retaining surface, but none to spare. In pack-

FIG. 514.

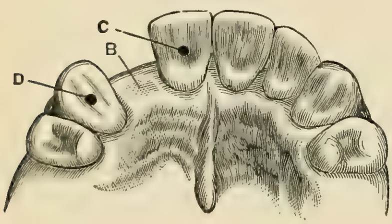
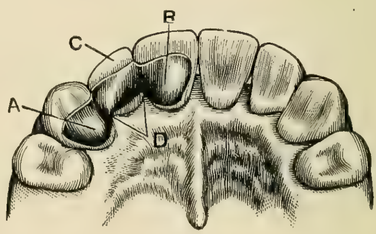


FIG. 515.



ing the cement around the pins, the under surface of the base-plates should at the same time be covered.

"The above details being perfected, the denture is at once carried to position, and with broad-pointed, serrated instruments pressed firmly into place, the excess of cement, if of the proper consistency, freely oozing at all margins.

"Too much care cannot be exercised in the cementing process. As every second of time is of value, all instruments required must be selected and conveniently placed before the oxyphosphate is mixed. To secure the most rapid, and at the same time thorough, admixture of the phosphoric acid and zinc oxid, a thick plate-glass slab, four inches square, with a flat (not a concave) surface should be used. The spatula should be of steel, thin and elastic, and $\frac{6}{10}$ of an inch wide. With these implements the whole mass of cement, acid, and oxid can almost instantly be brought into union, the

spatula being used as a muller. When a narrow and rigid spatula is used in mixing any considerable amount of oxyphosphate, the process can be accomplished only in detail, portion by portion, much valuable time being thus lost, during which the setting process is every moment hastening to its completion and rendering the cement unfit for use in this or any other form of bridge-work. A large excess of acid will, of course, make a thinner and more slowly setting mass, but a cement thus mixed is deficient in strength and too unstable to give good results.

"A very troublesome obstacle to success in the use of the oxyphosphate cements will often be found in the temperature of the air, an elevated temperature so hastening those chemical changes upon which the hardening of these cements depends as to render their use almost impracticable. This difficulty is likely to occur only in the hotter seasons of the year, and can readily be overcome by placing the mixing slab, as well as the acid and oxid bottles, in cold water until their temperature has been considerably reduced.

"During severe winter weather too low a temperature also gives trouble, the acid and oxid, even when the former is in some excess, forming a powdery mass utterly unworkable, but which melts down into an almost fluid condition when brought into contact with the warmth of a tooth *in situ*. A temperature between 60° and 65° F. secures the best results in mixing oxyphosphate cements.

"*Application to Pulpless Teeth.*—In the above description the vitality of the cuspid and incisor has been assumed; but, as can readily be understood, the pin and plate bridge can be even more readily and securely placed when one or both pulps are devitalized, for the reason that, the pulp chamber being empty, the pinholes in that tooth can be made as much larger and deeper as may be deemed desirable, the size of the pin being, of course, correspondingly increased. In a devitalized tooth, too, the base-plate can be sunk into the palatine surfaces when they interfere with occlusion, as sometimes happens when the antagonism of the lower teeth is very close and the overlap is considerable.

"Ordinarily, however, such interference is considerable, and the difficulty can always be overcome either in devitalized teeth by the expedient just suggested, or by carrying the base-plates as far away from the cutting edge as practicable, at the same time mak-

ing them at the point of contact as thin as is consistent with strength; finally, if necessary, removing a slight portion of the cutting edge of the occluding lower tooth.

"As experience with this as well as other forms of bridge-work has fully demonstrated, a slight mutilation of a natural tooth is far less destructive in its ultimate results than is the wearing of partial plates, in the use of which pressure falls upon the gum tissue, with the ultimate effect of stripping it from around the necks of the natural teeth, thus denuding them of that protective covering, and exposing them to the ravages of decay, and it may be safely affirmed that in all applicable cases the pin and plate bridge accomplishes its purpose with the minimum of injury to the natural organs.

"The small size of the retaining pins may excite doubts as to the strength of the denture; but pins smaller in size are constantly used for attaching porcelain teeth to plates, and in the upper incisors these pins are much less advantageously placed for resistance to pressure than are those imbedded in the natural teeth in the process above described.

"The weakest point in the bridge is not the pins, but the cement; this, while not so strong as the fused porcelain which surrounds the pins in artificial teeth, is, as experience has demonstrated, just strong enough to resist all ordinary wear and tear, without being so intractable as to render the removal of the denture for purposes of repair a practical impossibility by any method short of its destruction.

"Even with a good oxyphosphate cement, the work of removal is one of no slight difficulty, and requires the exercise of so considerable an amount of force that no one who has had occasion to perform that operation will question the security of any well-constructed specimen of this form of bridge. During an experience of some seven or eight years in their use, the writer has had but one or two cases in which the appliance became loosened, and only one in which it was detached outright. In the latter case the bridge (constructed with the natural tooth of the wearer instead of a porcelain substitute) had been firmly in position for more than a year, when the sudden wrench, consequent upon biting into a very hard peach, detached it. Being immediately replaced, it has since then done good service. In such cases it is

usually advisable to slightly deepen the undercuts in the pinholes before replacing.

"**Repairing.**—As in all other forms of bridge-work in which porcelain teeth are used, the accident most likely to happen is the fracture of this brittle material. As the bridge does not yield under pressure as does a detached plate, resting upon the compressible gum tissue, this form of breakage is one to which bridge-work is more than usually liable. For the pin and plate bridge, the least difficult method of repair is to separate the tooth and backing from the base-plates by means of a watch-spring saw, and then force off the base-plates singly, this being much more easily accomplished than their removal when united to the backing. Another tooth is then selected, fitted, backed, and soldered as before.

"As a rule, the writer has confined the use of this form of bridge to cases in which only a single incisor is missing, but he has successfully attached a front and lateral incisor to a cuspid and the remaining front incisor. When an unusual strain is to be expected, the retaining pins and pinholes should, when practicable, be made correspondingly large, or two smaller pins may be anchored in one tooth, which latter plan gives very great resisting power, and renders removal in the highest degree difficult and laborious." Prof. Litch informs us that, for his more recent operations of this class, he has adopted the method of using one plate only; that is, making the attachment to one of the adjoining teeth, but uses in this two small retaining pins, one of them being placed, say, near the cutting edge on the mesial side and the other on the distal side near the palatal edge of the plate. (See Fig. 511.)

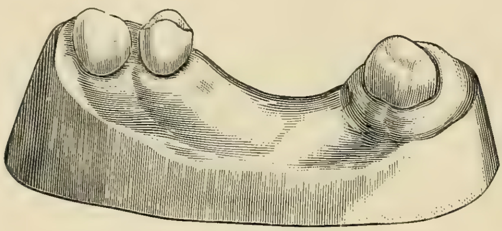
Under this head, plate and pin bridges, may properly be classed a process of replacement described by Prof. Litch in connection with the "pin and plate attachments" as a means of support for single front teeth, a method of attachment which, he says, although chiefly applicable to the incisors, may be combined with crown or bar bridges for molars and bicuspids.

"Fig. 516 represents a practical case in which the upper third molar and first bicuspid (both without antagonizing teeth) were utilized for the attachment of a bridge made of gold crowns with porcelain facings, to supply the loss of the intervening teeth.

"Fig. 517 represents the case as prepared for the bridge. A,

the inner cusp of the bicuspid cut down to allow the placing of a sufficiently thick crown-plate; B, a cylindrical undercut opening between the cusps for a retaining pin; C, the third molar made uniform in size from neck to grinding surface, the latter also being considerably retrenched; D, the crown-plate of a partial cap, made of pure gold, soldered with 20-carat gold, and so constructed as

FIG. 516.

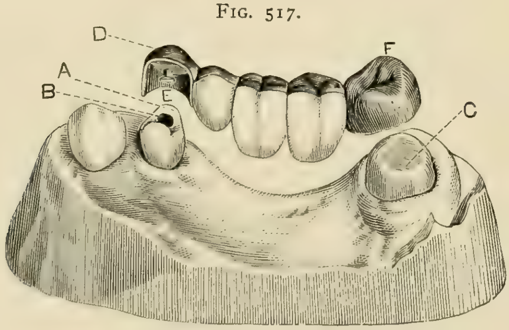


to cover every portion of the tooth except its buccal surface, the free edge passing up under the gum; E, a retaining pin adapted to the opening, B; F, the gold cap for the molar.

"Fig. 518 represents the bridge anchored in position with oxy-phosphate cement.

"In the above case it will be observed that there is a consider-

FIG. 517.



able space between the bicuspid and cuspid. This made it readily practicable to give so considerable a thickness to the mesial wall of the partial cap as to hold it securely against the side of the tooth. Had the space been less, contact with the cuspid would have afforded the desired security.

"Fig. 519 represents another case in which a bridge was at-

tached by a bar, partial cap, and retaining pin. A is an upper second bicuspid, without antagonist; B, its inner cusp cut down; C, opening for retaining pin; D, second molar, with slot for bar; E, cuspid; F represents the partial facing; G, the retaining pin; H, a molar crown of gold, with porcelain front; I, a platinum bar at-

FIG. 518.

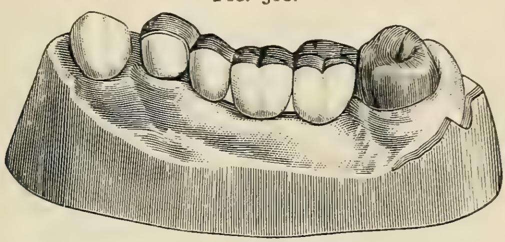


FIG. 519.

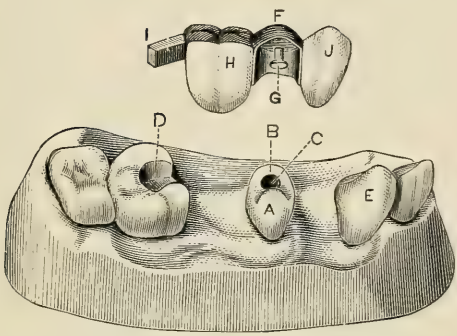
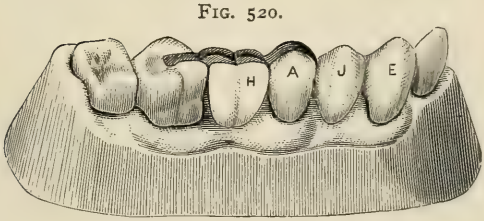


FIG. 520.



tached to the crown (H) and made to fit into a slot (at D); J, a plain plate cuspid, heavily backed and strongly soldered to the partial cap, but left without attachment to or contact with the cuspid.

"Fig. 520 shows the bridge anchored in position.

"This case, after two years of wear, is still in perfect condition and doing good service. As it was possible to keep the gold attachments, backings, etc., out of sight, the appearance presented is very natural.

"The bridge shown in Fig. 518 has been in use but a few months.

"The absence of antagonizing teeth for the bicuspids in each of these cases was a favorable condition, as a considerable thickness could be given to the crown-plate without any interference with occlusion. When the conditions are not so favorable, cutting down the inner cusp to the required extent and sinking the opening for the retaining pin to the necessary depth are processes certainly to be, as a rule, preferred to the entire removal of the crown for the purpose of ferruling the root for the mounting of a crown of gold and porcelain—a procedure, however, not by any means to be indiscriminately denounced, for in many cases it is in the highest degree advisable.

"There is this fact to be considered in regard to the use of the partial caps here figured—that many patients can be induced to consent to their employment who would refuse to submit to more radical measures, and thus, even when the latter would be advisable, the former may be employed as a compromise, or even as a temporary expedient. Having once tested the advantage of a well fitting bridge, the wearer is much more likely to consent to whatever measures are necessary to give it security and permanence.

"In the cases figured, however, as well as in analogous cases, these qualities seem to be amply secured. In every instance in which the removal of a pin and plate bridge has been necessary, the film of oxyphosphate cement has been found intact, and the surface of the tooth upon which it rested perfectly protected from decay. The only exceptions to this rule have been the very few cases in which one or the other of the retaining pins has become loosened, the bridge being for some weeks still worn in the loosened condition. Under such circumstances the cement will, of course, become detached and wash out, admitting food and secretions; but so long as the appliance remains immobile—and that is its normal state—the cement rests undisturbed. It need hardly be claimed that its durability is without limit, although under a metallic covering it appears to be practically so; but under the

conditions represented in the processes as above described, it is certainly good for many years of satisfactory service, and when it fails, through chemical abrasion, it will fail first at the free margins, where defects are most easily seen and remedied."

Dr. Register's Method.—The following is a condensed ac-

FIG. 521.

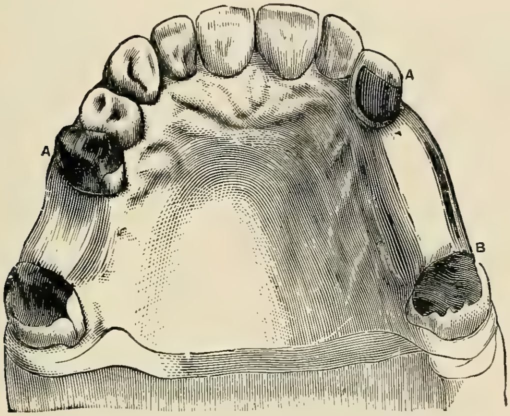
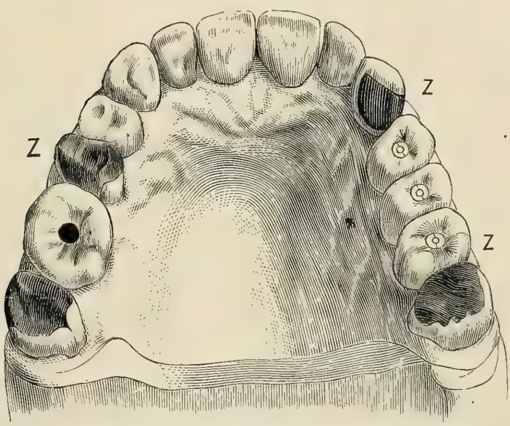


FIG. 522.

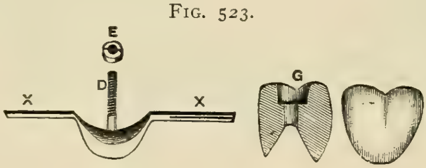


count, by Dr. Dexter, of a method of bridging devised by Dr. H. C. Register, one of the earliest experimenters in this method of replacement. The distinctive feature, as also the special merit, of Dr. Register's appliance consists in the provision made for the

ready replacement of broken crowns. The process is thus described:

"Taking a typical case (Fig. 521), a rim or saddle of gold, platinum, or iridinized platinum is struck to fit the spaces between the teeth A and B. To this are attached bars X (Fig. 523), to enter the fillings at Z Z (Fig. 522). Posts or pivots (D, Fig. 523) are soldered upon this saddle where the artificial teeth are to be placed, their free ends being threaded to carry the nut E. Hollow crowns, countersunk for the nut at G, and having the necks ground to reach over the saddle and press upon the gum, are fitted over each post. Amalgam is used to fill in the space between the post and the tooth wall, as in a Bonwill setting, and the crowns are drawn to place and held with the nut. The saddle is fixed in its place in the mouth, before the crowns are finally attached, by filling into the cavities Z, the bars X X."

FIG. 523.



Dr. Williams' Method.—Dr. J. L. Williams has given to the profession a number of important communications relating to bridge-work, to which space is given to such portions only as relate more especially to practical details. The initial portion of the following, reproduced from the *Dental Cosmos,* treats also of single crown replacement, and is embodied in this connection as having immediate and necessary relation to subsequent descriptions.

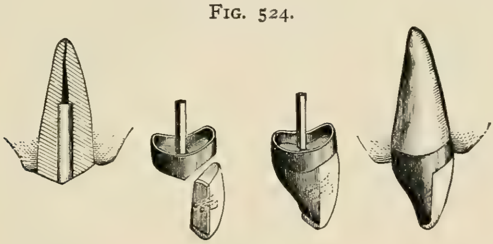
The following are Dr. Williams' descriptions of his methods of crown and bridge replacement:

After the end of the root has been properly shaped and a gold ferrule or band fitted to it, a suitable tooth is selected and backed with pure platinum, or pure gold. The cervical end of the tooth is ground to the proper position on the front bevel of the cap; all of the fitting being done while the cap is in position on the root. For detailed directions see Richmond ferrule or band crown, page 503.

After the fitting is completed, the cap is removed and the tooth

attached by strong resin wax and again placed in position while the wax is warm. Any slight change in position which is necessary can then be easily made. The tooth and cap are now removed together, invested, and united at the back by solder. It is well to use a solder for the cap with a higher melting-point than that used for the backing, as it obviates the danger of unsoldering the band when the backing is flowed on. After finishing and polishing the work, the end of the root is made perfectly dry, a sufficient quantity of oxyphosphate cement, mixed somewhat thinner than for filling purposes, is placed in the enlarged pulp canal and also in the cap. The crown is then carried to the place with firm, steady pressure, and held a few minutes until the cement is sufficiently hard to prevent displacement. The surplus cement which has oozed out around the band should be carefully removed, and the work is then completed. This is all illustrated in Fig. 524.

FIG. 524.



The bridge-work is simply an extension of the crowns over spaces where the natural teeth have been lost.

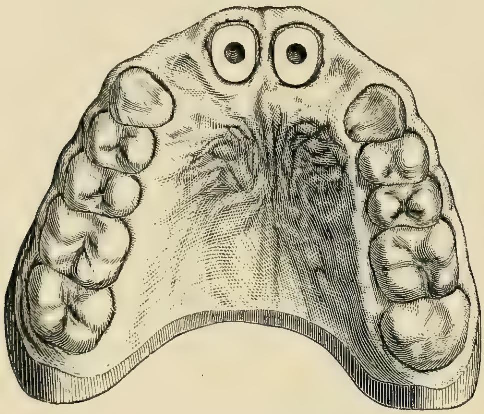
Fig. 525 was drawn from a model of a case in practice. In this the roots of the centrals are shown prepared for the fitting of the bands, the laterals having been extracted. Single crowns are made for these roots precisely as described. They are then temporarily placed in position. Laterals are selected, backed, ground, and fitted to position. The laterals are then attached by means of strong wax to the centrals, carefully adjusted in the position which we wish them to occupy, and the whole removed in an impression of investing material. An additional quantity of investment is mixed and poured over the exposed ends of the caps, and the whole allowed to harden, after which the investing material is cut away from the backs of the teeth and crowns, when they should all be united by soldering.

Fig. 526 shows the work completed, and Fig. 527 is from a model of the mouth as restored with the crowns.

In cases where the space is occasioned by the loss of more than one tooth a somewhat different method of procedure is necessary.

Fig. 528 shows a model of a mouth in which the superior

FIG. 525.



laterals and centrals had been extracted. The canines were badly decayed, with exposure of the pulp. The first step is the removal of the pulps from the canine roots. The crowns are then fitted as already described and placed in position. An impression is taken in plaster, the crowns remaining imbedded on its removal. The

FIG. 526.

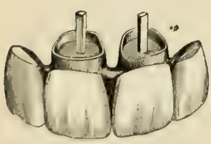


FIG. 527.

impression is varnished and oiled, and a model of investing material poured. After this has hardened, the impression is carefully cut away, and we have a model of the mouth with the crowns in position. A bite is taken and the articulation secured in the usual manner. The remaining crowns, having been

backed, are fitted, and the face of the work imbedded in investing material.

The whole piece is now united at the back by soldering, and when finished presents the appearance shown at Fig. 529.

Fig. 528.

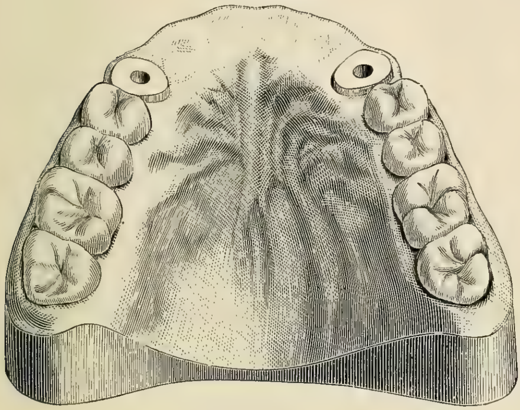


Fig. 529.

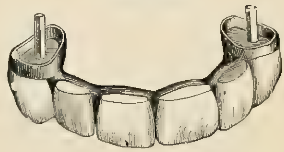
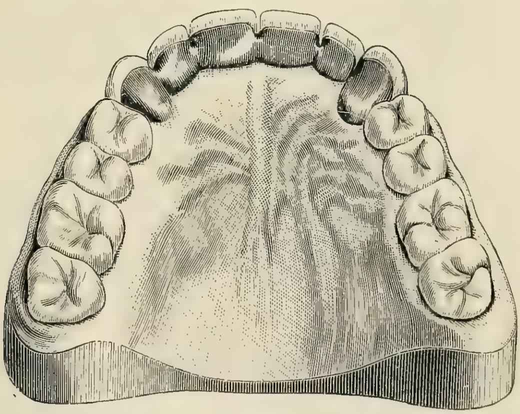


Fig. 530 shows a model of the mouth after the bridge has been cemented in place.

Fig. 531 is an illustration of a piece of this work for which there

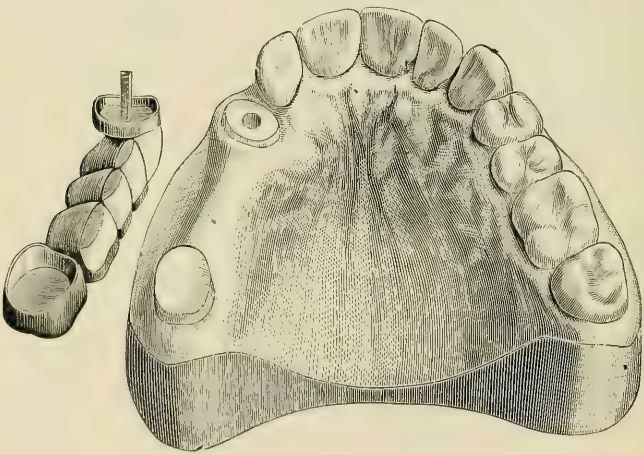
Fig. 530.



is a very frequent demand. It is for supplying the loss of the first molar and bicuspids. If the cuspid is intact, the anterior end of the bridge may be attached by a strong band of clasp metal passing

around this tooth, partly beneath the margin of the gum, so as to present the least possible exposure. If, as is frequently the case, there is extensive decay, it will be best to excise the remaining portion of the tooth and replace it with an artificial crown as shown in the illustration. The latter method the editor believes to be the better practice, even where the cuspid is a vital tooth. A gold cap is then made for the second molar. If this tooth is decayed it will only be necessary to remove the decay, and the cement which is used for setting the bridge will make the most perfect filling material beneath the gold cap. The intervening molar and bicuspid crowns are made in the following manner: The porcelain faces are backed with

Fig. 531.



gold or platinum and the tips ground squarely off. Zinc pattern dies, an assortment of which should be made from the grinding surfaces of molars and bicuspids, are used for swaging from pure gold a tip or cap for the protection of the porcelain face; for without this protection the porcelain would be almost certain to be broken. The concave surface of these tips is filled by melting coin-gold into them. This surface is then ground smooth and fitted to the squared surface of the porcelain face and waxed in position. Triangular pieces of platinum are then cut of the proper size to fit the sides of the tooth, waxed in position, and the whole invested, leaving the back open, which is filled with coin-gold. The several surfaces of a tooth thus prepared are shown in Fig. 532.

These teeth are then fitted into position in the bridge, as previously described.

Fig. 534 shows the completed work in the mouth.

Where only one molar or bicuspid is lost, sufficient support may be gained by the cap, which is made to pass over the adjoining molar. If the first molar and second bicuspid are lost, the ante-

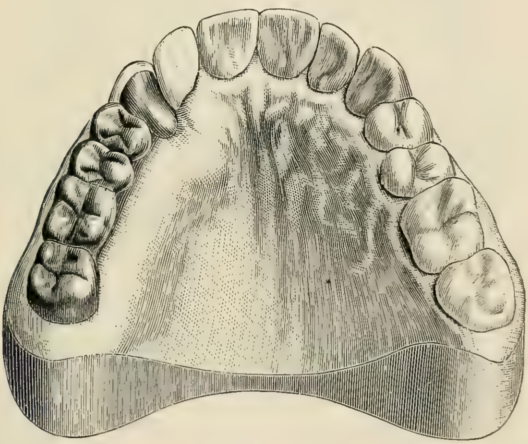
FIG. 532.

FIG. 533.

rior end of the bridge may receive sufficient support from a strong spur (Fig. 533), which may rest in the groove or sulcus between the cusps of the first bicuspid; or this groove may be deepened into a cavity, into which the spur projects and around which a filling is placed.

The most extensive pieces of this work which have been at-

FIG. 534.



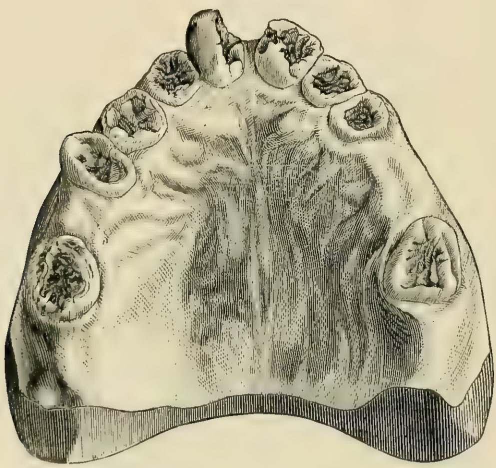
tempted are cases of 12 and 14 teeth upon three and four roots. Several of these have been worn for a year or more, and none of which we have any knowledge shows any signs of failure.

Perhaps we cannot better close this paper than with the description of the restoration of a mouth where any attempt to remedy

the ruin save by extraction would have been considered madness; and yet the lady for whom this work was accomplished is, to-day, so far as appearance, utility, and comfort are concerned, enjoying as perfect a denture as any person who has the same number of natural teeth intact.

Fig. 535 was drawn from a model of the mouth as presented. Only one tooth remained the pulp of which was not exposed—the left second superior molar. In the first bicuspid, cuspid, and central of the left side the pulps were exposed and in a partially putrescent condition. Abscesses had formed about the roots of the second left bicuspid, right central, cuspid, and second bicuspid.

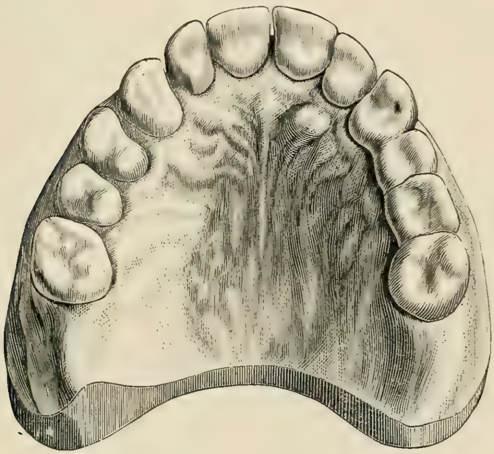
Fig. 535.



The pulp was slightly exposed and inflamed in the right first superior molar. The second bicuspid on the right side and both bicuspids on the left were extracted at once as worthless. The exposed pulp in the right molar was treated and capped. The partially living pulps were removed from the teeth above mentioned, the fistulous openings were healed, and all of the roots thoroughly cleansed, and plugged with orange-wood saturated with carbolic acid and glycerin. The greatest difficulty was encountered in the treatment of the right cuspid root, which had two large openings through the side of it, and through which projected into the enlarged pulp canal a tumefied growth of the peri-

cementum. For several weeks the tissues around this root were highly inflamed, and the face was several times badly swollen. The difficulty was finally overcome by covering these openings with No. 30 gold-foil and filling the root with amalgam. Crowns were then fitted over all of the roots. A bridge was then extended

Fig. 536.

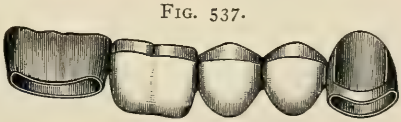


from the left cuspid to the first molar to restore the lost bicuspids. The missing bicuspid on the right side was restored by attaching the crown to the cap which was placed over the molar containing the exposed pulp.

Fig. 536 was drawn from a model of the mouth as restored.

Fig. 537 shows a piece of work made for a case of quite fre-

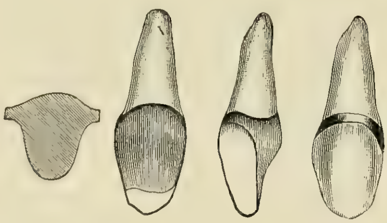
Fig. 537.



quent occurrence. It represents the restoration of the inferior bicuspids and first molar of the right side. A gold crown is made for the second molar, and then the three intervening teeth, or "dummies" are made as has been previously described. For the support of the anterior end of the bridge the method hitherto practised has been to excise the crown of the cuspid and fit a

porcelain crown with gold backing to the root, and to this the anterior end of the bridge is soldered. We have, however, in Fig. 538 illustrated a device which obviates the necessity for removing the cuspid crown. A gold band is fitted around the cuspid. At the front, shown at *a,* this band is allowed to pass a little beneath the margin of the gum so as to make the smallest possible exhibition of gold. On the lingual aspect of the tooth this band is allowed to be nearly the length of the crown. It will be seen that when this band is fitted as perfectly as possible there must necessarily be quite a vacancy between the upper part of the lingual surface of the tooth and the band. It is important that this portion of the band fit the tooth perfectly, and an accurate adaptation is obtained as follows: A piece of pure gold, rolled to No. 35 American gage, is fitted over that portion of the lingual

Fig. 538.



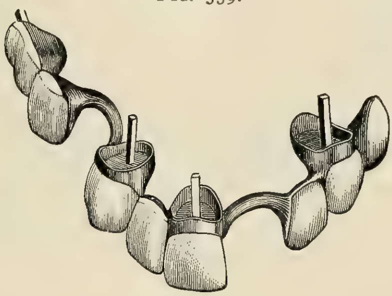
d *c* *b* *a*

surface of the tooth which it is desired to cover. *d,* in Fig. 538, shows the shape that this little pure gold plate usually assumes. It can easily be fitted perfectly by the use of a burnisher, and then, with the band in position, a drop of melted resin wax is flowed into the space between the pure gold and the band. It is now removed from the tooth, invested, and, after melting out the wax, solder is flowed into the vacancy, filling completely the space occupied by the wax. The top of the lingual portion will now be thicker than is necessary, but can be easily ground or filed down to the proper thickness. We now have a band which fits all portions of the tooth perfectly. The anterior end of the bridge is soldered to this band, and after work is properly finished it is cemented in place in the usual manner; *b* and *c* show side and lingual views of this band after the fitting is completed.

Another device for obviating the necessity for removing the

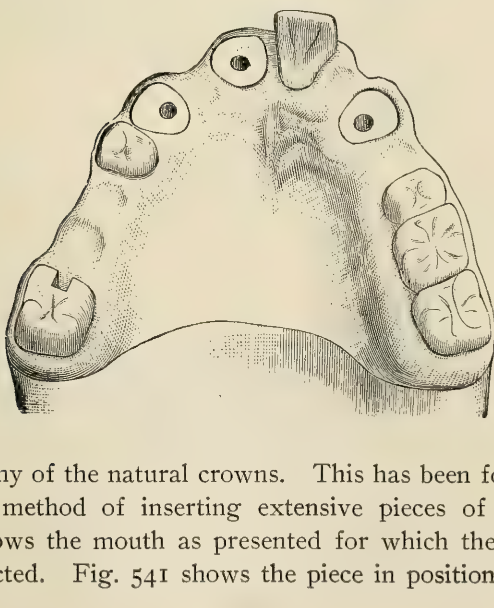
crowns of natural teeth in preparing the mouth for bridge-work is illustrated in Fig. 539. Crowns are fitted in the mouth to the points of attachment in the usual manner. An impression is taken, bringing the crowns away in their proper positions. From this the cast or

FIG. 539.



model is obtained. Heavy bands of half-round gold or platinum bars are now fitted around the necks of the natural teeth on their lingual surfaces. These bands being waxed in position, serve to connect the different parts of the bridge, uniting them in one piece without

FIG. 540.



the loss of any of the natural crowns. This has been found a highly satisfactory method of inserting extensive pieces of bridge-work. Fig. 540 shows the mouth as presented for which the piece shown was constructed. Fig. 541 shows the piece in position.

Fig. 542 illustrates a case which is a type of a class of frequent occurrence. Alternate molars and bicuspids in the upper and lower jaws are lost, until the occlusion is somewhat changed, and

FIG. 541.

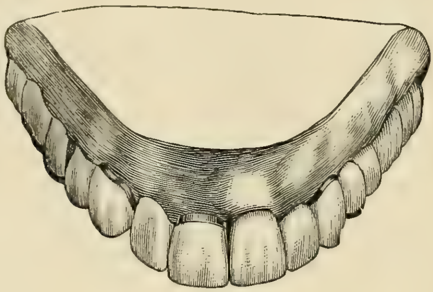


FIG. 542.

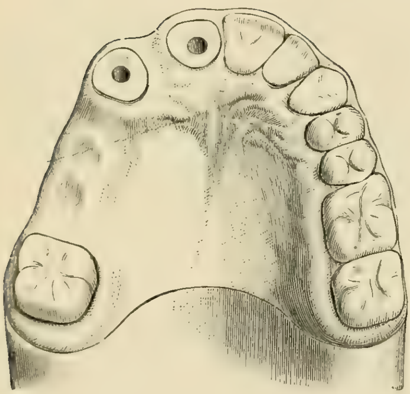


FIG. 543.

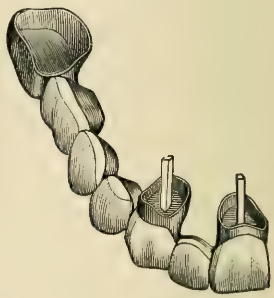


FIG. 544.

the force of mastication is gradually brought upon the front teeth. Rapid wearing of these teeth results. The cases are among the most difficult that the operator is called upon to treat by the

ordinary methods. In the case herewith illustrated, the lower bicuspids, with a molar on one side, were in good condition, but the loss of the upper bicuspids and molars made them useless. As usually happens, the upper incisors had suffered most. The lower incisors were restored by capping them with cohesive foil. The bridge shown in Fig. 543 was constructed for the right side of the upper jaw, while the teeth on the left side were restored by contour work, as shown in Fig. 544.

The superiority of the condition of this patient's mouth, which resulted from this work, over anything which could have been accomplished by plate-work, is almost inconceivable to one not familiar with these methods.

Dr. Knapp's Method.—After constructing the crowns as directed on page 420, suitable plain plate teeth should be backed

FIG. 545.

FIG. 546.

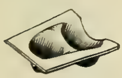


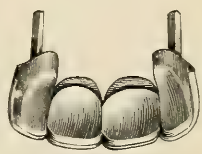
FIG. 547.

FIG. 548.

FIG. 549.

FIG. 550.

FIG. 551.



with pure gold and built up to the desired shape with wax, Fig. 545, which should be incased in pure gold as before described, Figs. 546, 547, and 548. After investing and subsequent removal of the wax, the resulting receptacle can readily be filled with 20-carat solder, Fig. 549.

In the preparation and in the drilling of the roots, great care should be exercised to have the caps and the pins as nearly parallel as possible. Here, as well as elsewhere, sound judgment is essential to the accomplishment of the best results. For the attainment of accuracy, it is essential that an impression should be taken, preferably in plaster, of the caps in their proper positions upon their several roots. An impression should likewise be taken of the occluding teeth. The models obtained from these impressions should then be placed in an articulator, as for plate-work,

and the articulating surfaces of the porcelain crowns should be carved in wax to a nicety. By the methods just mentioned these occluding surfaces are reproduced in gold. The requisite exercise of the dental organs and immunity from breakage of porcelain faces are in this way secured. The porcelains should not press upon the gums except in the anterior portion of the mouth, where the formation of the alveolar process permits and the perfection of speech demands it. The gold from the grinding surfaces should form a gradual slope until it reaches the porcelain, and should be entirely free from pits and other irregularities. When they occur, it becomes necessary to remedy these as well as other defects. This is to be done by the refiring of either a single crown or an

FIG. 552.

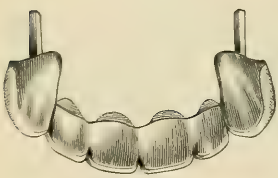
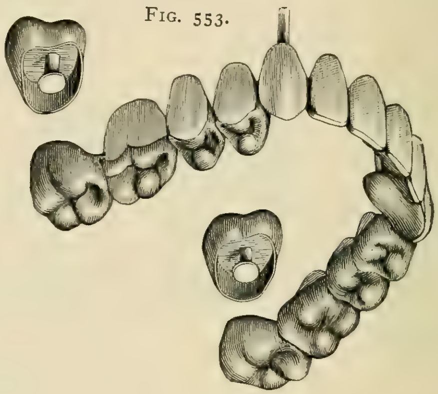


FIG. 553.



entire piece of bridge-work. At times gold, where needed, may be added by the use of the electric mallet, and a beautiful finish obtained with it. Under all circumstances, both porcelain and gold should present a perfect continuity of surface. With diligent attention given to the important details of construction which are here pointed out, the great bugbear of uncleanliness, suggested as an objection to this method of substitution, is entirely removed. Of course, food and salivary deposits will accumulate around artificial crowns as well as about natural teeth, and the personal cleanliness of the wearer is the greatest and indeed sole safeguard against such injurious accretions with any denture. A philosophy that would condemn the insertion of bridge-work, artistically con-

structed on scientific principles, on the score of uncleanliness, would as consistently advise the extraction of the natural organs for the reason that their possessor was a sloven. "Cleanliness is next to godliness," says Wesley, and he who expects to wear a "crown," here or hereafter, must heed this maxim.

Fig. 550 shows an upper central and lateral incisor mounted upon a central root with spud attachment. Fig. 551 represents the four upper front teeth held in position by the two lateral roots. Fig. 552 the six upper front teeth mounted upon the two cuspid roots. Fig. 553 represents a full upper denture with the two cuspid roots and two molars as anchorages.

For the attachment of crown- and bridge-work the best obtainable oxyphosphate cement should be used. With the pins notched, and the roots perfectly free from moisture, sufficient oxyphosphate should be placed around each pin and inside of the collar to completely fill all the space between the pin and the canal, the collar and the root. Firm, well-directed pressure should then be exerted to carry the piece to its proper position, where it should be held for a few minutes to permit of the hardening of the cement, all excess of which oozing through at the edge of the collar should be carefully removed. Before being dismissed, the patient should be instructed to be a little cautious in regard to subjecting the crown or bridge to any force for a short time.

Dr. Low's Method.—The following illustrated account, descriptive of Dr. J. E. Low's methods of procedure in the cases under consideration, was especially prepared by him for this work. His definition of "bridge-work" has special application to his distinctive method of construction. It is as follows:

"Bridge-work consists of supplying vacancies between teeth or roots with artificial teeth, attached to the adjoining natural teeth or roots by means of bands or crowns, and held in such a position that there is no contact with or pressure on the gums beneath, and thus no opportunity for secretions or other foreign matter to be held there, and thereby become offensive.

"There is really but one kind of bridge-work, and but one way to make bridge-work to insure success. There are many ways of making teeth without plates, but this is not bridge-work.

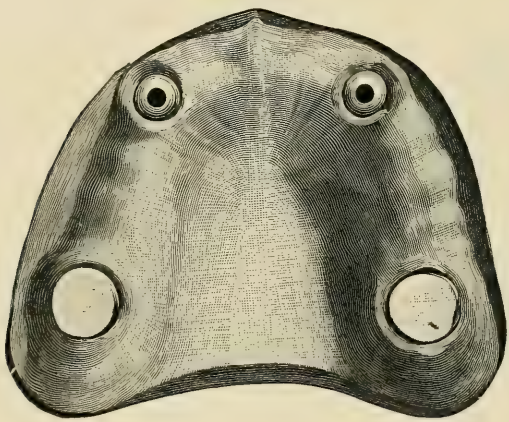
"For the first illustration, as seen in Fig. 554, we have a case

where all the teeth have been extracted except the two cuspids and two second molar roots.

"First proceed to prepare the roots by crowning. I use gold crowns on the molar teeth, and what is known as the Low crown on the cuspids. The preparation of the two cuspids consists in making the crown ready for adjustment, the process of which is about the same as for the Richmond crown. I always measure the tooth to be crowned with gold with a strip of block tin, No. 35 thick Stub gage or thereabouts. Place the tin around the tooth, and with pliers carefully measure the full size of the same.

"Should you be measuring a tooth, or part of a tooth, on which

Fig. 554.



there are projections, take the engine, and with a stone grind off the same, making a smooth surface, so there will be nothing to interfere with the fitting of the bands properly. After cutting the tin measures by the marks made by the pliers, you have the measures ready to make the gold bands by. Cut the bands and bevel the edges and solder together, and you are ready to fit. After fitting all the bands and finishing the crowns in the usual way, place each in position in the mouth, having previously regulated the articulation of each crown as desired, in the process of making. We now take a deep articulation in wax, and impression in plaster-of-Paris; remove before it gets too hard, and place all the crowns in their positions in the impression; varnish, oil, and

pour in the usual way; separate the cast from the impression and place in the articulator. Then pour with plaster. After the plaster has hardened, remove the wax, and we have the articulation proper, and are ready to select and grind the teeth, having previously selected the shade. My experience has long ago taught me that no porcelain tooth can stand the pressure for bridge-work, the strain on them being twice as great as with teeth on plates which rest on the gums, that give to pressure. In order to prevent breakage of teeth and give strength, we must supply the teeth with gold cusps. I will here describe my manner of doing so.

"For the first step, use No. 28 gage platinum for a covering of the inside of the tooth, or just where you wish gold to flow. Then bend the pins down to hold the platinum in position, and with a file remove all overlapping platinum to prevent breaking of the tooth in heating. The tooth is made flat on the crown surface with the express intention of restoring with a gold crown. This crown need not be very thick, but should perfectly resemble the cusps on the natural tooth, for the purpose of mastication. As these cusps are not on the market, and every dentist making bridge-work cannot make it in a way to stand without putting gold cusps on the grinding surface of the bicuspids and molars, I will here describe how they can be made with very little trouble. Pick out a natural tooth with cusps the exact shape you wish to have your gold cusps resemble; mix up some fire clay in a thick paste; then press your tooth into it a little deeper than you wish the cusps. Having made the proper impression remove the tooth, and set the impression over the gas-stove to dry. After it is dried and reasonably hot, lay your pieces of gold in the impression and with a blowpipe melt them. When melted, press with a piece of steel on the gold till cool. This mold will do to make many from. If you have not the fire clay, and can get charcoal that is burned from fine-grained wood and is soft, you can simply press your tooth into the charcoal and melt in the same way, or you can carve your teeth as you desire in a block of carbon. Of course, the little steel die-plates are handier, as we can swage up our gold cusps in them, either solid or thin.

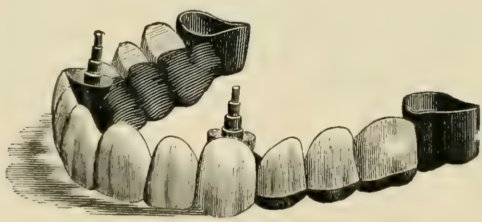
"Having described our manner of making the cusps, we will now return to the finishing of the tooth. We left off by saying we covered the inside and bent down the pins and filed off

the overlapping platinum. Now place the cusp on the top of the tooth, and place in the position desired, holding it there with wax, and with a spatula trim the wax the exact shape we wish our tooth to be, V-shaped, tapering from the crown down. We now incase in plaster and sand, which gives us a box. When hard, remove the wax and place over the stove, and when sufficiently dry fill in with coin-gold, using the blowpipe to melt it in a solid mass, and our tooth is ready to file up and place in position on the articulator. Fig. 555 shows the tooth in this condition.

FIG. 555.

"After our teeth are arranged, we hold the same in position with wax, remove from the articulator, incase with plaster and sand or asbestos in the usual way. That we may have a strong case, I always place platinum wire between each tooth, and then proceed to heat and solder. Be sure that all the gold cusps are so arranged that you can get it all soldered together, as this gives great strength. My formula for solder, which will be found very easy-flowing, and almost the exact color of the gold you are using, is as follows: Always figure from the carat of gold you are working. Take one dwt. coin-gold, two grains of copper, and four of silver. We now have our case soldered; after filling as

FIG. 556.



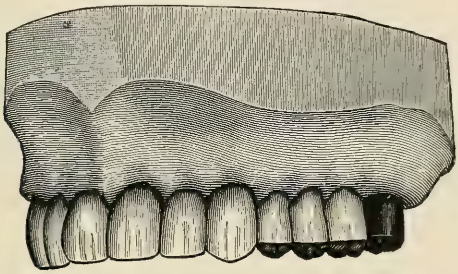
desired, commence to finish with felt wheels and pumice-stone, after which use rouge on buff wheels. It is now ready to be placed in the mouth. In Fig. 556 we see the case ready for adjustment.

"Have the assistant dry all the teeth or roots to be operated upon while you are mixing the cement. Be sure and use a kind which will not harden very rapidly, or your cement will set before you get your teeth home. Use sufficient cement to fill all the gold crowns perfectly when the case is driven to place. Moisten the step-plugs and cap with cement, touching every portion, and

with an instrument place a little cement in the bottom of the cavity. We now adjust our case, using a wooden plug for driving on the crowns. Fig. 557 represents the case when in position.

"It will be seen by looking at the previous cut (Fig. 556), that the teeth, after having been soldered, are all spaced fully one-third of the distance from the place of contact with the gums and the

FIG. 557.

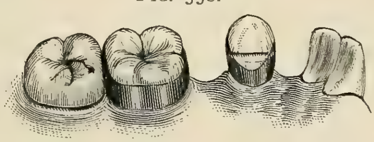


grinding surface of the teeth, so that secretions could not possibly lodge there."

Dr. Melotte's Method.—Dr. G. W. Melotte, of Ithaca, N. Y., contributed to the *Dental Cosmos* an account of his method of bridging in a given case, the manipulative details of which are here reproduced:

"Fig. 558 illustrates a case for the supply of a lateral and a bicuspid. In this instance the cuspid should be cut off, and the

FIG. 558.



root collared and capped in combination with a pin entering the enlarged pulp canal; but, as there may be grounds for objecting to cutting off sound teeth, I obviate the necessity by cutting a shoulder on the lingual portion of the cuspid, and suitably shaping its sides to permit a close fitting of the collar just under the free margin of the gum. A narrow strip of pure pattern tin, bent tight around the tooth neck, and cut through with a knife at the lap on the labial surface, will serve as a measure for the length of a strip

of 22-carat gold plate, No. 29, thick, and as wide as the length of the distal side of the cuspid. The ends of the gold are then squared, and with round-nosed pliers brought evenly together, to be held in flush contact with suitable pliers. The soldered collar, with its joint side inward, is then adjusted on the tooth as accurately as possible, giving slight blows with a mallet until the collar touches the gum, when it should be marked to indicate the necessary trimming to conform it to the gum contour. After it has been thus trimmed, the edges beveled, the labial part swelled with contouring pliers, and the lingual part cut down to about $\frac{1}{10}$ of an inch in width, the collar is again driven on, and will appear as seen in Fig. 558. A stump corundum wheel is then used to grind a shoulder on the lingual surface of the tooth, grinding also the edges of the collar flush with the shoulder. The collar is again removed, and a piece of thin platinum plate, about No. 32,

Fig. 559.

Fig. 560.

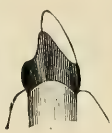
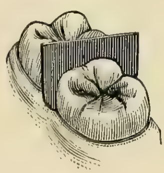


Fig. 561.



sufficient to cover the lingual surface of the tooth, is caught on the lingual edge of the collar by the least bit of solder, and all put in place on the cuspid (see Fig. 559). The platinum should now be burnished on to the shoulder, and over the tooth and collar to the extent shown by the lines in Fig. 559. After trimming to those lines, and carefully replacing and burnishing to the tooth, the collar and half cap are removed, filled with wet plaster and sand, and the platinum soldered to the gold. It is then placed on the tooth, burnished into all the inequalities of the tooth, very carefully removed, invested, and enough solder flowed over the platinum to cover and give it strength. Fig. 560 shows it complete on the cuspid. I have often made such collars in less than an hour, and in any case time must be made subservient to exactness of fit and adaptation to the end in view.

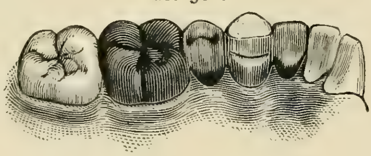
"In the preparation for fitting a collar on the first molar (Fig. 558) I should have wedged or otherwise separated it from the

second molar, so that a piece of sheet-brass might be put in place, as shown in Fig. 561, and an impression taken in plaster, which, if allowed to get hard, would bring away the metal. If not, it could be replaced in the plaster. Melted fusible metal, when near the cooling-point, is then poured into the impression, and when cold will allow the safe removal of both the plaster and the metal strip. On this metal model a collar can be formed that will accurately fit the molar, as seen in Fig. 558. If the molar has no antagonist, a cap may at once be struck up on the model; but if there be an antagonist, the cusps of the natural molar should be removed by grinding at points where the occluded tooth will admit of sufficient thickness of the gold cap. An exact copy of the ground cusps can then be made in less than five minutes by the use of moldine with its accessories, see page 138, and the process is as follows: Make the tooth perfectly dry. Put the collar on it. Nearly fill the cup with moldine, and coat it with soapstone powder. Press the compound on the tooth and collar firmly to about one-fourth the depth of the tooth. Carefully remove the cup; trim off any overhanging material, and place the rubber ring over the cup to about one-half the depth of the ring. Melt the fusible metal and pour it as cool as it will run from the iron ladle. As soon as the metal is hard, remove it with the ring, taking care not to impair the impression, which can be used again if the die is found imperfect or gets injured in use. Place the die and ring in cold water, to remain until quite cooled. While the die is wet and held over a basin of water, pour into the ring fusible metal which has been stirred until it begins to granulate, and quickly immerse all in the water. The die and counter-die should separate readily by tapping them with a hammer, but if they stick, others can be quickly made from the same impression, by the same method, using more care. With this die and its counter-die, a piece of No. 29 or 30 gold plate is swaged to fit perfectly the cusps and collar, which, when removed, can be held to its place on the cap by the soldering clamp, using spring pressure enough merely to hold them together for careful soldering with the pointed flame so as not to unsolder the collar. The seamless collars are excellent when care is used in selecting the proper size, as directed on the diagram.

"The caps being in place on the cuspid and molar, an impression is taken with plaster, the caps accurately set in the impression, and

hard wax melted with a hot spatula around the edges of the caps. The impression is then thoroughly coated with sandarac varnish, after which it is dipped for a moment in water and filled with a wet mixture of one part marble-dust with two parts of plaster, using great care to perfectly fill the caps and molds of the teeth. Wait until this mixture has become quite hard, remove the cup, and with a suitable knife clip off the plaster without marring the cast; secure a good articulating impression, and transfer it to the cast to obtain an exact reproduction of the relative occlusions of all the teeth involved. With such an articulation in hand, and with the means already described for swaging gold or platinum plate to fit the cusps and articulating surfaces of either the natural or artificial teeth, it should be within the capacity of any competent dentist to complete a suitable bridge, although there are practical points that can only be imparted by clinical instruction and actual demonstration in the mouth. Such a bridge is shown in position in Fig. 562."

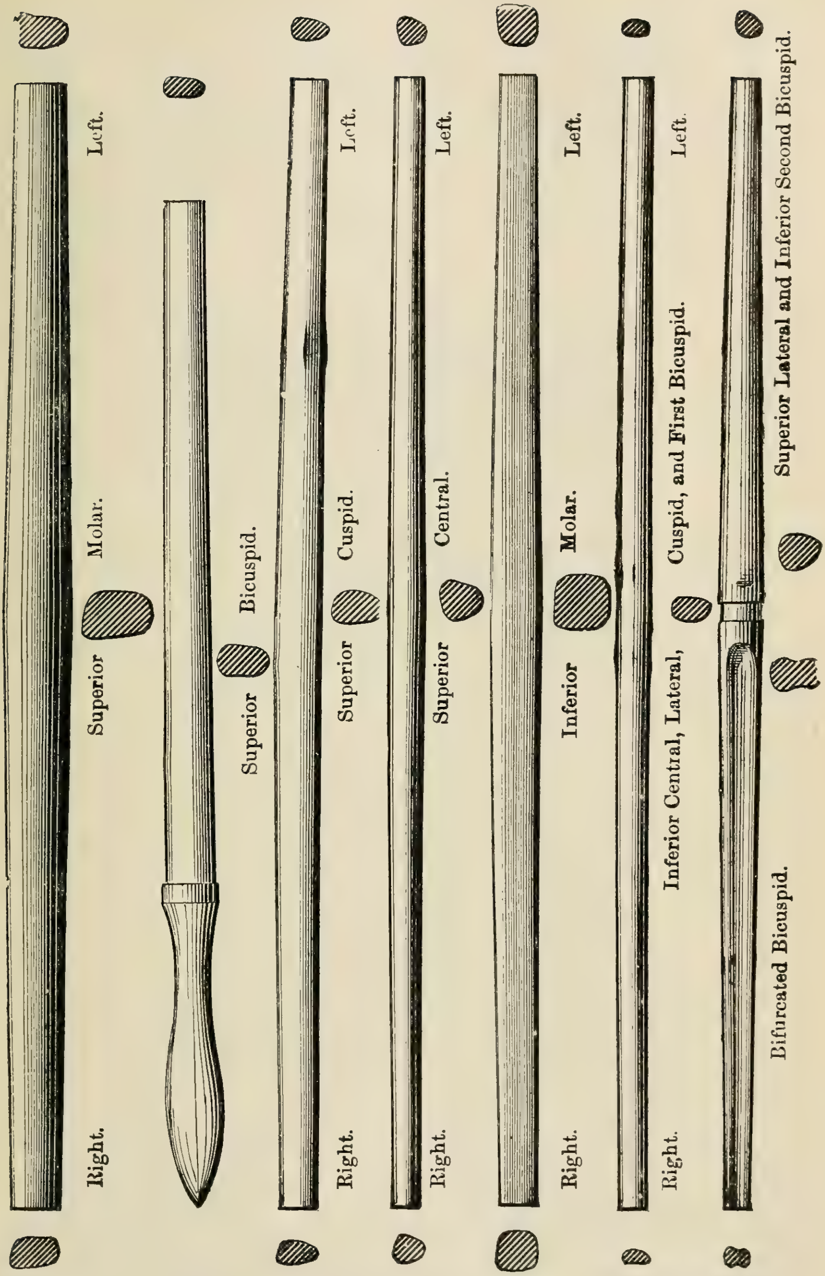
FIG. 562.



The Mandrel System.—The following description of "A System of Crown- and Bridge-work" is given by the experts of the S. S. White Manufacturing Co., who have designated it as "The Mandrel System":

"An examination of a large number of human teeth shows that, no matter how great differences may exist in the apparent shapes of the crowns of individual teeth of a given class, there is a remarkable uniformity in the configuration of their necks. That is, the necks of upper cuspids, for instance, were found to have a fixed type, from which the variations were very slight as to shape, though there appeared to be no exact standard of size. So of the other classes, with the single exception of the superior molars, in which two distinct forms were found, the first being those in which the buccal roots were wider than the palatal; the second, those in which the reverse condition was found, the single palatal root being wider at its junction with the crown than the two buccal roots.

Fig. 563.

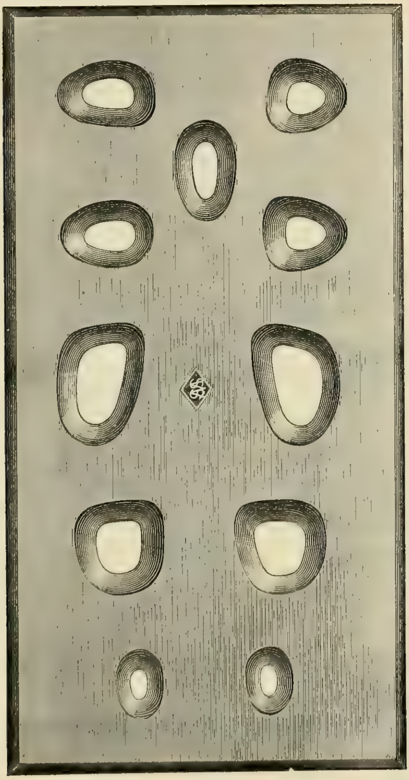


Mandrels for shaping seamless tooth-root collars.

The occurrence of roots of the second class being rather exceptional, the first class was accepted as the type.

"The configuration of the necks of all the teeth having been determined, a set of mandrels for shaping collars to fit them was devised. The set (Fig. 563) consists of seven mandrels, six of which are double end. Their shapes are modeled upon the general typal

FIG. 564.



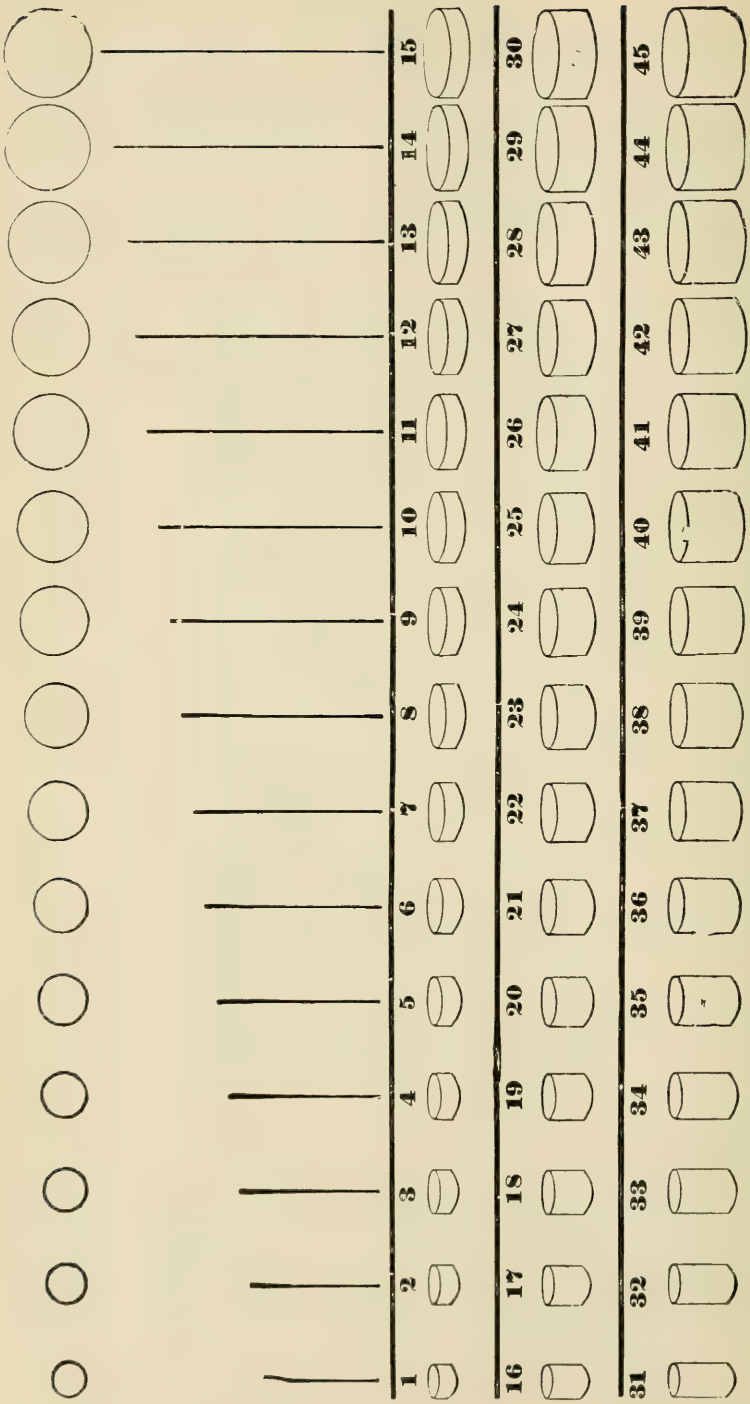
forms of the necks of the teeth which they represent, and they are made tapering to provide for all required variations in size. The illustrations are about two-thirds actual size, the longest instruments being nine inches in length. The cross-sections show the shapes and proportionate sizes at the greatest and least diameters. The long taper permits the most minutely accurate adjustment of the collars.

"No. 1 is a double-end mandrel, for superior molars, right and left; No. 2 is a single mandrel, for superior bicuspids, right and left; No. 3 is a double-end, for superior cuspids, right and left; No. 4, double-end, for superior centrals, right and left; No. 5, double-end, for inferior molars, right and left; No. 6, double-end, for the inferior centrals, laterals, cuspids, and first bicuspids, right and left; No. 7, double-end, one end for the superior lateral incisors, the other for those bicuspids in which a bifurcation of the roots, or a tendency in that direction, extends across the neck to the crown in the form of a depression on one or both approximal surfaces. The foregoing scheme comprehends all the teeth of the permanent set except the second inferior bicuspids. The necks of these approximate those of the superior central incisors so closely in shape that it was deemed inexpedient to make a separate mandrel, as the No. 4 mandrel will serve for both.

"The collars or bands are made seamless, of No. 30 (American gage) gold plate, 22 carats fine. Fifteen sizes, each of three widths ($\frac{1}{10}$, $\frac{2}{10}$, and $\frac{3}{10}$ of an inch) are made (Fig. 565), which it is believed will cover all requirements. These collars, although devised as a part of the system, can be used in all methods of crown- and bridge-work which require bands, and possess many advantages over any others. They are really labor-saving devices, as their use saves the time and trouble of making, and there is no danger of their coming unsoldered when the pins or the backing of the crown are being soldered; and there are no hard spots to give trouble in burnishing, as, for instance, close to the root, after the collar has been shaped and placed in position, the whole surface being uniformly soft.

"The seamless collars are also especially adapted to removable or detachable bridge-work. They are so constructed that Nos. 1, 16, and 31 exactly fit into or telescope with Nos. 2, 17, and 32, and so on through the entire set, each collar fits into the series next higher; so that a root may be banded with one size and the size next larger used to form the tube for the telescoping crown. When desirable, the 'seamless' collar can be strengthened, after it has been adapted to the conformation of the crown so as to slide freely over it, by investing and flowing solder over the outer surface; or, still better, by adapting the next larger size of collar to exactly fit around the first, and then investing the two and soldering them

FIG. 565.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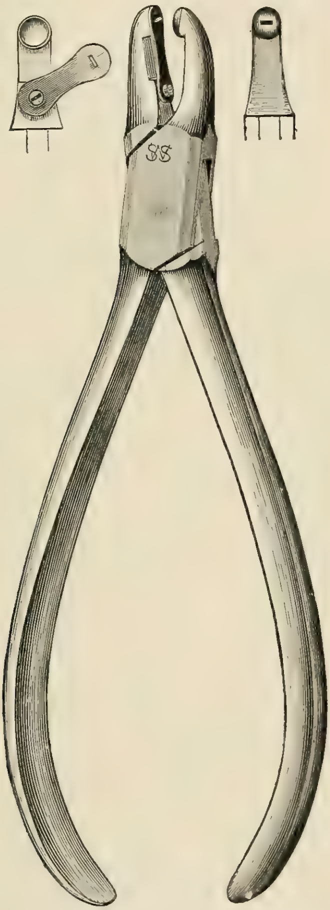
together. The advantages of these collars for this kind of work, and also for the construction of cap crowns, are obvious.

"The other appliances specially devised for this system are, a reducing plate or contractor, a pair of collar pliers, and a hammer.

Fig. 566.



"The contractor (Fig. 564) contains holes which are complementary in shape to the mandrels. The mandrels being applied to the inner circumferences of the collars, while the contractor must admit the collars themselves, the short taper of the holes in the contractor necessarily covers a somewhat greater range of size than

is shown in the mandrels. With this appliance collars can be evenly and accurately reduced in size at the edges, without burring or buckling. The illustration is actual size.

Fig. 567.

"The collar pliers (Fig. 566) are for contouring the collars to shape, one beak being made convex and the other concave to correspond. With this appliance the slightest changes required in the contour of the collars are easily made. About ½ of an inch from the extremity of the concave beak a small bar of flat steel is attached to it by means of a screw. The free end of the bar has a minute projection upon one face, the other being reinforced to fit into the concavity of the beak. In the center of the face of the convex beak is a depression, into which the projection on the steel bar strikes, making a very efficient punch for forming guards or stops to prevent the collars from being forced too far under the gum. The depression in the convex beak being slightly larger than the projection or punch, the metal is not cut through, but merely raised on the side opposite to the punch. The punch attachment being pivoted can be swung to one side when not in use.

"The mallet or hammer, with steel face and horn peen, is shown in Fig. 567.

"One of the appliances required is a lead anvil, which, being only a piece of soft lead, say two by three inches, and an inch thick, is not illustrated. The counter-die of an ordinary case will answer very well.

"To illustrate the uses of these appliances, take a case in which the two inferior bicuspids of the left side are missing, and the crowns of the cuspid and first molar so badly decayed that the probabilities are that they will soon fall victims to the forceps. The old-time way would have been to extract the molar and cuspid, and make a partial plate. Examination, however, shows that the roots of these two teeth are in good con-

dition, affording an excellent opportunity for the construction of a piece of bridge-work.

"With a corundum stone, cut off the remaining portions of the crowns level with the gum margins. Prepare the roots in any of the well-known ways, thoroughly cleansing the apical portions and filling them with whatever material is desired, being careful only that the work is well done. For the better retention of the filling material to be placed in the pulp chamber, retaining grooves can be made or retaining posts inserted. Take a piece of binding wire (No. 26, American gage), say 2½ inches long, pass it around the neck of the molar stump, cross the free ends, and, holding

FIG. 568.

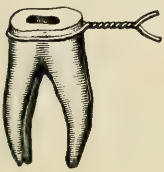


FIG. 569.

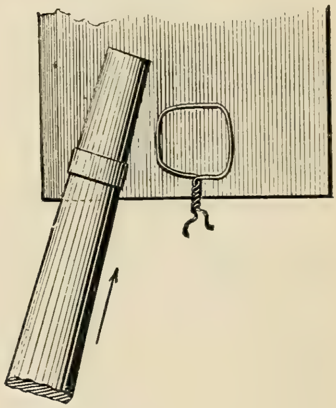
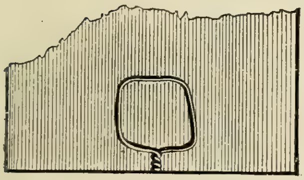


FIG. 570.



the wire in place with one finger, twist the ends with a pair of flat-nosed pliers until the wire clasps the tooth closely at every point (Fig. 568). When there are any irregularities in the contour of the tooth, it is necessary to press the wire into them with an approximal burnisher. It is obvious that the ring thus formed will show the exact size and shape of the neck of the tooth. Remove the ring carefully, lay it on the lead anvil, put over it a piece of flat metal, and with a smart blow from a hammer drive the wire into the lead (Fig. 569). Upon removing the wire an exact impression of the ring will be left in the lead anvil, as shown in Fig. 570. (This part of the work, as indeed all others, should be done carefully as described. The wire ring may be driven

into the lead by a direct blow of the hammer face, but the blow might not strike equally, and the interposition of the flat metal held level insures an even impression. A piece of an old file is best, as the file-cuts keep the wire from slipping.)

"Next, cut the wire ring at the lap, straighten out the wire, and select a suitable collar by comparing the length of the wire with the straight lines in the diagram, which show the inside diameters of the various sizes. Should none of these correspond exactly, take preferably the next size smaller. It will be remembered that the collars are No. 30 in thickness, while the wire with which the conformation is secured is No. 26. This difference permits the collar, when contoured to shape, to enter the lead impression readily, a decided advantage in fitting. Having selected the collar, fit it to mandrel No. 5, with the peen of the hammer, holding it upon the lead anvil, and using a slight pushing force to help in stretching and forming it (Fig. 569). Having driven the collar to form, remove it from the mandrel and try in the lead impression. If it does not fit exactly return it to the mandrel and stretch it a little, when it will usually fit perfectly, as the mandrels have been designed carefully to the average shapes which obtain in the great majority of tooth necks. In the exceptional cases where the collar does not fit, it can readily be contoured to the exact shape with a pair of flat-nosed pliers. Of course, if it fits the impression in the lead, it will fit the neck of the tooth, always provided the measurement and the impression have been carefully made.

"If the collar or band has been accidentally stretched too much, or if, for any reason, when brought to shape, it is too large, its root end can easily be reduced to the proper size by the use of the contractor. Place the edge of the collar which is to fit in the root in the proper hole; hold it level with a piece of file as in taking the lead impression of the ring, and tapping lightly on the file drive the collar into the plate (Fig. 564) until the proper reduction is made. The collar is next 'festooned' to correspond to the shape of the maxillary ridge. Lay it, gum edge up, on the lead anvil, and with the piece of flat file and the hammer drive it into the lead. A few cuts with a fine half-round file across the approximal diameter will conform the edges to the surface of the ridge (Fig. 571). Then place the collar in position, and, having ascer-

tained just how far it should go down on the root, remove it, and with the small spring punch in the collar pliers (Fig. 566) form projections on the inside of the band at the proper points to serve as stops, which, resting on the top of the root, will prevent the collar from being forced further down upon it than is desirable (Fig. 572).

"A collar for the cuspid is then fitted in the same manner,

FIG. 571.

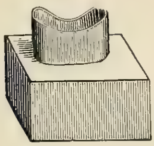
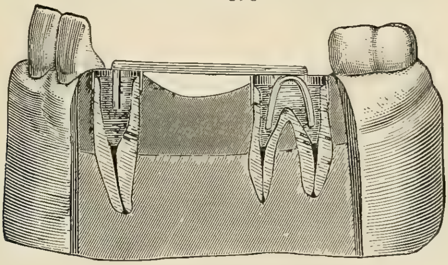


FIG. 572.

using mandrel No. 6 for shaping, after which the case is ready for the building of the bridge.

"Place both collars in position and take an impression of the parts, including the interiors of the excavated pulp chambers, from which make a cast in the usual way. Bend a short piece of half-round gold or platinum wire into the form of a horseshoe, the two extremities of which shall fit into the roots of the molar.

FIG. 573.



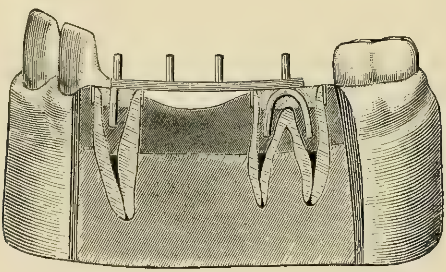
Then take a longer piece of the same wire, somewhat more than enough to extend from the toe of the horseshoe when in position to the cuspid root; bend one end of it at a right angle, or nearly so, to fit the root of the cuspid, and, cutting off any excess of length, solder the other end to the toe of the horseshoe. The bar extending between the two roots is the truss of the bridge. Next, place the appliance on the cast (Fig. 573), holding it in

position with wax, and select the teeth to take the place of the missing bicuspids and molar. The best form for this purpose is a tooth having holes extending through it vertically from the neck to the grinding surface, similar to the well-known Bonwill crown.

"The crowns used should be large enough to fill the space rather tightly, even if their sides have to be flattened to let them in. If the teeth do not fill the space perfectly, a small portion of plastic filling material crowded between them, as mortar between the granite blocks in the arch of a railway bridge, will greatly increase the strength of the work.

"After the teeth are ground to fit, and the proper length for occlusion ascertained, the truss is covered with a film of wax, upon which the crowns are again pressed to their positions. Upon the

Fig. 574.

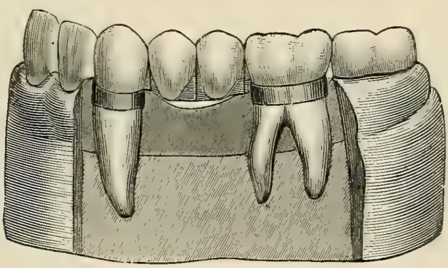


removal of the crowns the impression of the holes running through them will be found in the wax. At these points drill holes through the bar with a small twist drill run by the dental engine, and into these fit and solder the pins for the support of the crowns, as shown in Fig. 574.

"The bridge is now ready to be attached permanently. Set the crowns in position upon their supporting pins, to secure the proper alignment. (If the operation were upon the upper jaw they would have to be held with wax.) Put into the canals of the supporting roots (the cuspid and first molar) a sufficient quantity of some quick setting plastic, as oxyphosphate, to about half fill the pulp chamber, but not enough to prevent the supports of the truss from being forced home. Force the bridge supports to place, and after allowing the filling material to become set remove the crowns.

Fill the remainder of the pulp chamber and the whole of the collar with gold, amalgam, gutta-percha, oxyphosphate, or other suitable plastic (Fig. 574). Set the crowns permanently, the molar and cuspid first, as this affords greater facility for the trimming off of any excess of the filling material used in the attachment. For attachment of the crowns gutta-percha is probably the best material, as crowns set with it are readily removed for the correction of any inaccuracies of occlusion or alignment by grasping them between the beaks, previously warmed, of a pair of universal lower molar forceps. The heat warms the gutta-percha and releases the tooth, which can then be reset properly. In attaching crowns with gutta-percha, the holes in the crowns are first filled with the material, after which the crown is warmed and forced to place. Any of the other plastics ordinarily used can be employed,

Fig. 575.



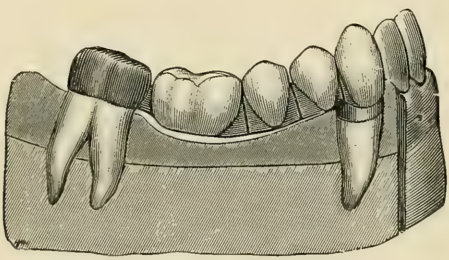
at the discretion of the operator. Fig. 575 shows the case completed.

"In securing the occlusion of a piece of bridge-work it is well to make the artificial teeth a little short, so that the natural teeth on both sides will meet the first shock of mastication. Nature will correct the occlusion in time by slightly elongating the roots supporting the bridge. If the artificial crowns are permitted to strike the natural teeth from the first, the undue strain upon the two supporting roots will cause soreness and, perhaps, more serious consequences.

"When a sound tooth is to be used as one of the supports of the bridge, a modification of the method just described is necessary. Take a case where it is desired to bridge the space caused by the loss of the right inferior bicuspids and first molar. The crown of

the right cuspid is nearly gone, but the root is sound and capable of supporting one end of the bridge. The other end will be attached to the second molar, which is a sound tooth. Prepare and band the cuspid root as before, dress off the second molar crown until it is slightly smaller than the neck, so as to permit a cap to be telescoped over it, and take the measure of the crown with the binding wire. Select a suitable seamless collar of sufficient width to extend from the neck to a little beyond the grinding surface and drive it up on the proper mandrel to get the general shape, but not the full size required to fit the tooth, leaving it so that the edge having the larger circumference will just pass over the end of the crown; place the collar on the tooth and with a block of wood and the mallet tap it to place just beyond the free margin of the gum. This method will make a close fit, as the collar will readily stretch

FIG. 576.



all that is necessary. With a sharp-pointed instrument mark the length of the crown, remove the collar, and cut it to the proper width as indicated. Then in a piece of gold plate of the thickness used for caps form four little depressions of the general character of an impression of the molar cusps. An easy way to do this is to lay the plate on the lead anvil; then with the ball on the end of an ordinary socket handle and the hammer the depressions are made in a moment. Set the collar on the plate, borax it, charge with solder, and heat until the solder flows. Cut off the surplus plate, and a perfect cap for the molar is made. Place it on the tooth and take an impression, and thereafter proceed as before directed to make the truss of the bridge and mount the teeth, except that in this case the posterior end of the truss is to be soldered to the molar cap. For the final attachment place a little

oxyphosphate or other plastic filling material in the cap to secure it firmly in position."

The Hollingsworth System.—This system supplies, in the first place, a variety of forms for the various teeth great enough to cover almost any case, and for the rare cases which cannot be suited direct it affords a ready means of making the exact form required. They are made of metal, and are used as patterns from which to make dies or molds, as may be required, for the swaging of gold cusps or crowns. There is, therefore, no wear upon them, and they retain their shapes and sizes unaltered.

The outfit for working these forms consists of a molding-plate, three rubber rings, a sheet of asbestos, 10 × 7 inches, and a carbon stick for use in casting.

FIG. 577.

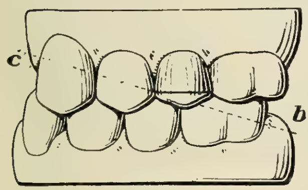
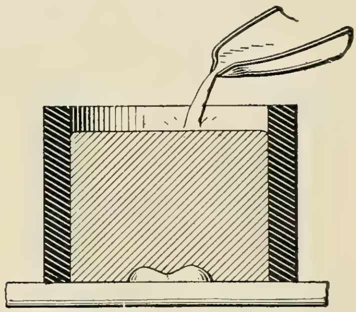


FIG. 578.

FIG. 579.

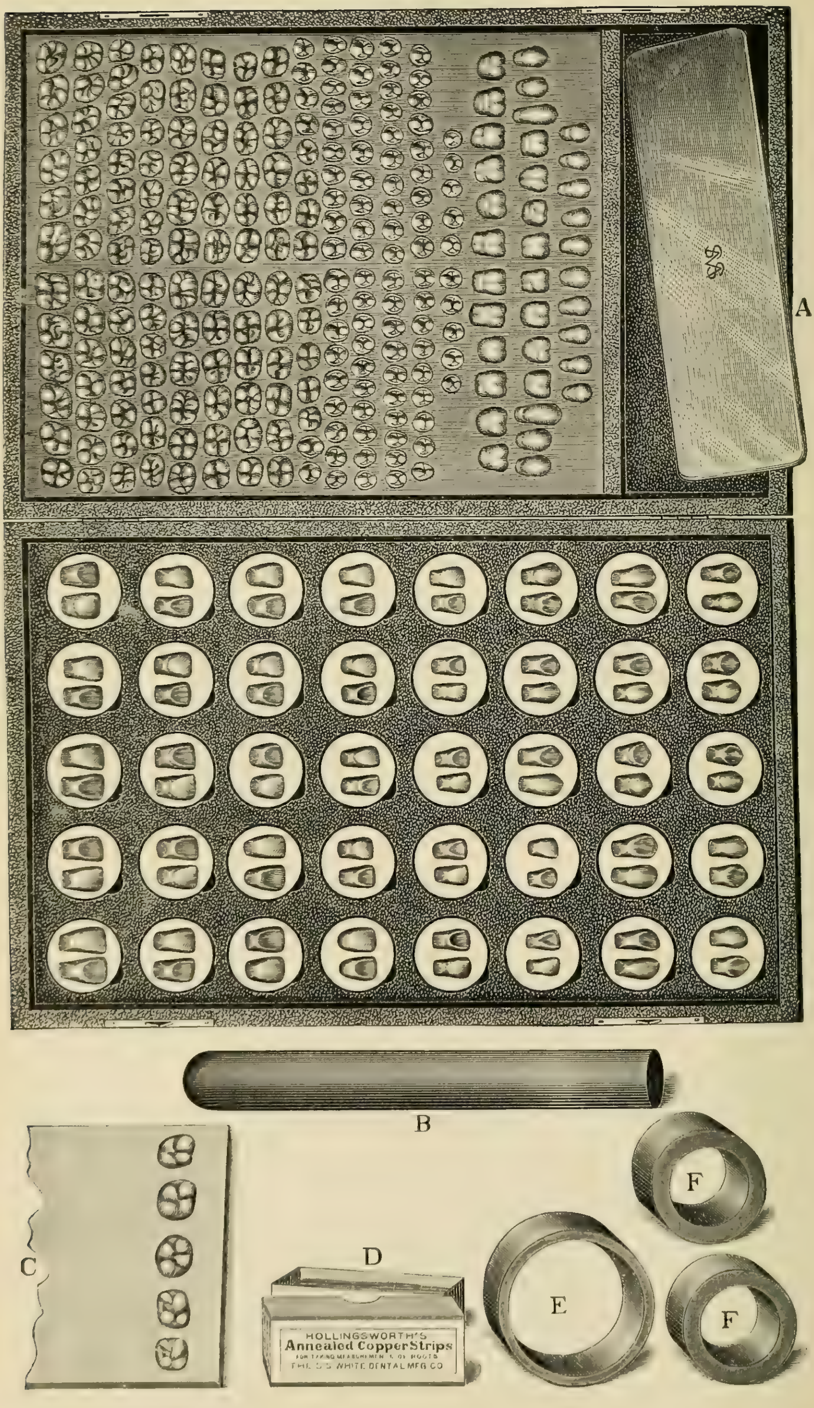


This system permits cusps to be made either hollow or solid. Scrap gold can be used for casting solid cusps, and porcelain facings can be quickly inserted in crowns without investing; but perhaps its most important advantage is the exactness with which the fit and articulation of bridges are obtained and maintained.

The features which Dr. Hollingsworth claims for his methods are illustrated in the following directions:

After making a band to fit the root in the ordinary way, place it in the mouth (see Fig. 577), and cut off on a line where the adjoining teeth begin to turn to form the cusp (see *c*, Fig. 577). Place a small piece of wax inside the band to assist in holding the cusp button, which should be selected to fit the circumference of the band, to articulate properly, and to correspond in shape with the other teeth (see *b*, Fig. 577). Remove the button, and place it on

Fig. 580.


A
B
C
D
HOLLINGSWORTH'S
Annealed Copper Strips
THE S. S. WHITE DENTAL MFG. CO.
E
F
F

the molding-plate with the grinding surface up (see Fig. 578). Place the small rubber ring *d* around it, with the button as near the center as possible, and pour in a sufficient quantity of Melotte's metal to nearly fill the ring (Fig. 579). Start to pour the metal directly on top of the cusp, otherwise the flow of metal may force the cusp to one side and make an imperfect die. As soon as the metal sets, chill the surface by dipping in water for a moment, and then remove the rubber ring. When the heat begins to return to the surface, a quick rap of the die on the bench will cause the cusp button to drop out and leave the mold ready to form the gold cusp. Now take a small piece of lead, and with a few taps of the ham-

FIG. 581.

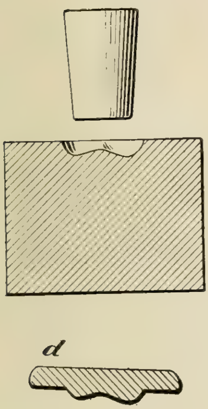


FIG. 582.

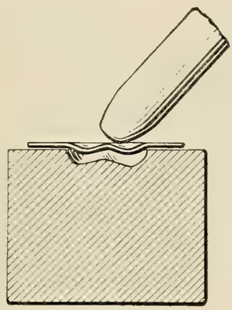


FIG. 583.

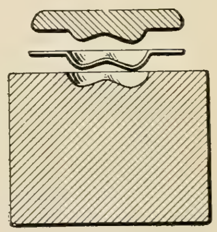
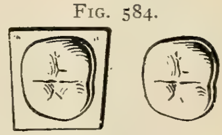


FIG. 584.



mer drive it into the Melotte metal die (Fig. 581) to form the counter-die (Fig. 581, *d*).

Anneal the gold plate, and start the swaging process by coaxing the plate into the die by hand pressure (Fig. 582), using a piece of wood, which makes a depression for the lead counter-die to rest in. Then place the counter-die on the gold plate (Fig. 583), and drive to a partial fit. Remove the partially formed cusp, pickle it to remove traces of lead, and again anneal it. Place the counter-die on the die without the gold plate and drive it in with a smart blow; this will resharpen all the lines of the counter-die. Next replace the partly formed gold cusp in the die, and again drive the counter-die into it for a perfect fit. Again pickle the cusp and proceed to cut the surplus metal from it with shears (Fig. 584), filing up the

edges when necessary, and rub down the under surface on a smooth file until it fits the band made for it (Fig. 577). Wire the cusp and crown together (Fig. 585), place flux and solder in the cap, and hold over a lamp until soldered. Then finish in the usual way.

If the forms of cusp buttons do not afford one which articulates perfectly, the difficulty is easily remedied by taking the button which most nearly answers, and building up the cusps with Melotte's moldine (Fig. 586). If necessary to make an absolutely perfect articulation, and the forms as supplied do not permit of it, select a cusp that will otherwise suit the case, set it on the band on the crown, cover the face of the cusp with moldine, coating the

Fig. 585.

Fig. 586.

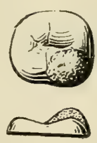
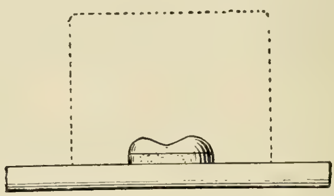


Fig. 587.



surface with collodion to prevent the saliva from crumbling it, and direct the patient to bite upon it, or, if a perfect plaster model has been made, articulate the opposing teeth with the cusp placed on the band, omitting the coating with collodion. Remove the cusp with the moldine, trim off the surplus, and proceed to cast as shown in Fig. 579. If a band is accidentally cut too short, it can still be utilized. Place moldine upon the molding-plate, put the cusp button upon it, press down and adjust to make up the deficiency of the band, cutting away the surplus moldine. This will, of course, throw the soldering line a little further up on the crown (Fig. 587).

Solid Cusps.—Scrap gold can be utilized for making a solid gold cusp by casting in asbestos by the following method:

After selecting the desired cusp button, instead of making a mold in Melotte's metal, as before described, take a piece of asbestos board about one inch square and ¼ of an inch thick, moisten it, and with a hammer drive the cusp button into it, flush with the surface of the button. (See Fig. 589.) Remove the button, and dry

the asbestos in a flame (Fig. 588). When perfectly dry, place a sufficient quantity of gold scraps in the die made in the asbestos, and direct the blowpipe flame upon it until melted, inclining the carbon stick, as shown, against the die for the double purpose of confining the heat and warming up the carbon stick. When the gold is fused into a button, press it into the die with the carbon stick (Fig. 590). *Avoid the use of flux when working with asbestos.*

To build up a cusp to make a perfect articulation in this manner, sealing-wax must be used instead of moldine, as in the method of swaging the cusp. Warm the button before applying the wax, and with a warm instrument shape the cusp as desired.

FIG. 588.

FIG. 589.

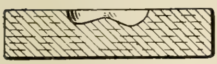
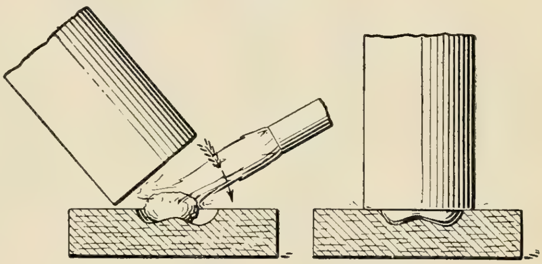


FIG. 590.



Gold Central, Lateral, and Cuspid Crowns.—Select from the 40 different forms in the set that which is most suitable to the case in hand (Fig. 591). (The forms are in pairs, showing labial and lingual surfaces.) Take the measurement of the root to be crowned with one of the annealed copper strips, binding the strip around the tooth with pliers and pinching the joint firmly together. Trim off the surplus ends, and cut the measure (Fig. 592, *a*) through the center (Fig. 592, *b*), then bend the respective halves over the lingual and labial forms selected, at the necks, with the cut ends of the strips resting on the flat of the plate (Fig. 593). If the measure is larger than the form selected, build the latter up with moldine until the space between the form and strip is filled (Fig. 593, *b*). Avoid getting moldine on the approximal surface. Remove the strips, dry out the moldine by passing through a flame a few times, then place the form on the molding-plate with a rubber ring around it. Pour Melotte's metal into the ring as in forming the molar or

bicuspid cusp, which makes a die of the two sections, lingual and labial. Make a lead counter-die and proceed as directed in the making of a molar cusp, swaging the sections separately (Fig. 594). Trim off the surplus plate (Fig. 596), and square the opposing

FIG. 591.

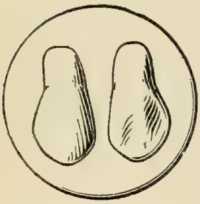


FIG. 592.

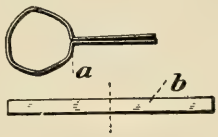
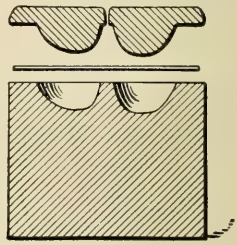


FIG. 593.

FIG. 594.



edges of the two sections by rubbing them over a dead smooth file. Bind the two sections together with wire with sufficient solder and flux inside (Figs. 597 and 598), and proceed as in soldering an ordinary band. With a small mechanical saw cut off the upper

FIG. 595.

FIG. 596.

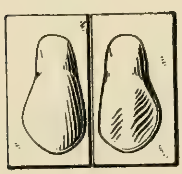


FIG. 597.

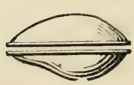
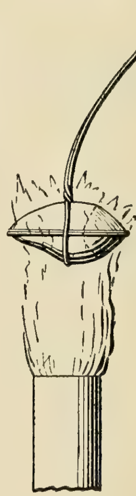


FIG. 598.



portion where the tooth begins to slope back (about the dotted lines in Fig. 598). This leaves the crown as shown in Fig. 595, approximal and labial views. Drive on the root. If too small, place on the horn of an anvil and enlarge by hammering; if too large, band

the root in the same manner as for a Richmond crown, grinding the tooth to fit.

Porcelain Facings.—First make the gold crown as described. Select a porcelain facing suitable for the case (Fig. 600). Place the crown on the root in the mouth, and with an excavator mark on the face where the porcelain is to appear. Remove the crown and saw out, so that the facing will fit loosely. With a knife bevel the inner edge or seat for the facing (Fig. 603). Grind the facing to fit (Fig. 605). Back up the facing with No. 34 or 36 gage pure gold, punching holes in the backing for pins, annealing as required

Fig. 599.

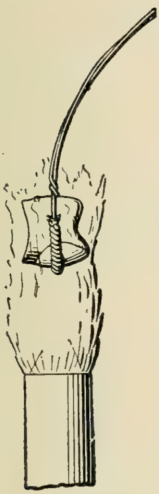


Fig. 600.

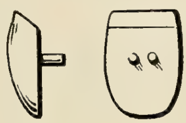


Fig. 603.

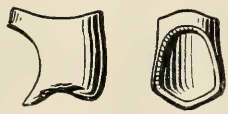


Fig. 605.

Fig. 601.

Fig. 602.

Fig. 604.

Fig. 606.

Fig. 607.

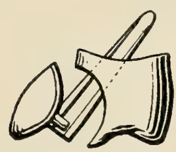
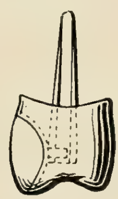


Fig. 608.



to readily conform it to the tooth (Figs. 601 and 602). With a sharp knife cut a barb on each side of the pins in the facing, and press the barbs against the backing (Fig. 604), to keep the backing in place. Burnish down the edges well, being careful not to let the backing overlap the facing.

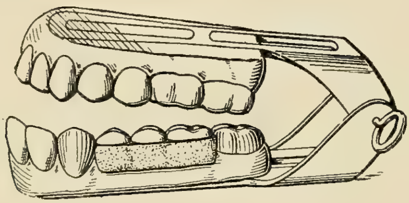
Place the facing in the space prepared for it in the crown (Fig. 606), and bind the two together (not too tight) with wire, wrapping the wire directly over the facing with asbestos to prevent discoloration of the porcelain. Flux and solder by holding over a lamp as in the case of a band (Fig. 599). Then finish in the usual way.

If it is desired to use a platinum pin for anchorage, as, for in-

stance, a Logan pin, bend the pins in the facing sufficiently to clamp the anchorage pin, and insert the pin through the gold crown (Fig. 607), finishing as before described. Fig. 608 shows a finished crown so made.

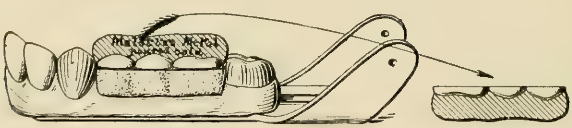
The Grinding Surface of a Bridge in One Continuous Piece. —After having crowned the teeth for the attachment of the bridge, take a bite in modeling compound, remove the compound, place the crowns in their impressions, make a cast of sand and plaster,

Fig. 609.



and place on an articulator; now put moldine between the abutments instead of wax, and get the articulation with cusp buttons the same as you would for plate teeth (Fig. 609). Then to remove the buttons without destroying the articulation, make a cup by pouring Melotte's metal, as cool as it will flow, on the face of the cusp buttons. Heat the pouring lip of the ladle and use it to smooth out the half congealed metal, much as you would a soldering iron (Fig. 610). Then place a thin coating of moldine

Fig. 610.



upon the molding-plate. Remove the cup from the articulator with the cusp buttons in place (Fig. 610, *a*). Transfer the cusps by inverting the molding-plate (Fig. 611), and turn the cusp buttons out upon the moldine on the plate with the grinding surface up (Fig. 611, *a*), and they will occupy the same relative positions as when on the articulator.

Now place the large rubber ring around the buttons on the plate, and proceed to make a die with Melotte's metal. When cool,

remove the buttons, and coat the face of the die with whiting. Invert the die and raise the rubber ring sufficiently high on it, and make a counter-die with the same metal by pouring as cool as possible (Fig. 613).

This gives the male and female dies with which to swage the continuous grinding surfaces. Then proceed to swage the gold plate in one piece (Fig. 614), annealing as often as necessary.

Fig. 611.

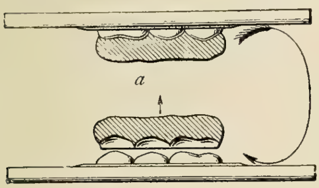
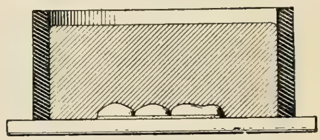


Fig. 612.



Trim off the surplus plate (Fig. 614, *a*), and place in position on the articulator. Cut the cusps out on the buccal face to avoid showing the gold (Fig. 615), grind the porcelain facings to fit the cusps, and back with gold, No. 34 or 36, letting the gold come to the cutting edge, the same as in a single crown, as before described.

If there is a space between the cutting edge and the porcelain,

Fig. 613.

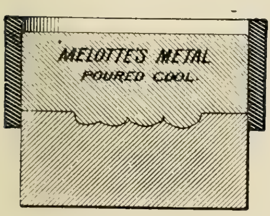


Fig. 614.

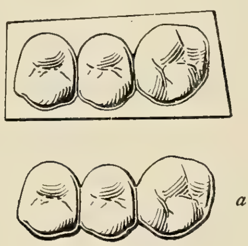
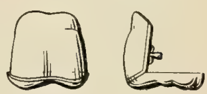


Fig. 615.



place a little wax in the joint to keep out the plaster investment, invest, remove the wax from between the joints, flux, and solder.

Facings for an All-gold Bridge.—If it is desired to make an all-gold bridge, select the proper facings from the set, make a die of Melotte's metal, and swage up, the same as in the continuous bridge before described, and mount gold facings in place of porcelain.

Dr. Parmly Brown's Method.—Dr. E. Parmly Brown describes a process of bridging which is characterized as "all-porcelain." This is true only in the sense that no metal is visible, all parts of the metal framework being concealed within the body of the porcelain. The method is as follows:

A lateral view of a porcelain crown, with a platino-iridium pin baked in position, is shown in Fig. 616. The pin has great strength at the neck of the tooth, where the strain is greatest, the porcelain of the tooth extending up on to it, to increase the strength; a front view of the same crown is seen in Fig. 617, showing by dotted lines the form which the metal occupies in the crown to increase the strength of the attachment, and prevent the pin from approaching the surface in thin teeth.

Fig. 618 is a view of the two-pin bicuspid crown, which affords

FIG. 616.

FIG. 617.

FIG. 618.

FIG. 619.

a pin for each root of a two-rooted bicuspid, the staple form of the pin, shown by dotted lines, being a feature of strength.

Fig. 619 is a view of a bicuspid crown with the two pins pressed together, making a single pin for the one root.

The double pin in the bicuspid crowns prevents the loosening of these teeth by the rotary movements of mastication, which by means of the two cusps exert such leverage as to turn and break down the ordinary crown where only one pin is used.

This bridge-work system has the metal baked invisibly through the body of the teeth. No metal shows either inside or outside of the dental arch. The six anterior teeth are riveted to the platino-iridium bar by the ordinary pins of plate teeth, which are the teeth used for this work. The bicuspids and molars are prepared by grinding a slot on the palatal surfaces of the teeth. The bar, which is squared for these teeth, instead of being flattened, as for the front teeth, is inserted into this groove or slot, which should be ground with a thin corundum wheel to fit the bar,

which can be barbed to make proper impingement. It is then ready to receive the creamy tooth body, which at this juncture is applied to the palatal surface of all the teeth, completely covering the metal and giving the natural contour to the inner surfaces. A little of the tooth-body is allowed to run between the teeth, uniting their approximal surfaces.

In this work, when cross-pin teeth are used, the pins will be ground out in most cases; but if straight-pin teeth are used the pins will be bent over the bar. We will give a few illustrations of the many ways in which this work can be done.

Fig. 620* is a view of a platino-iridium bar baked on to a plain plate tooth, by first riveting the flattened bar on the pins, then applying tooth body to the back, completely covering bar and pins, and then baking in continuous-gum furnace. The body, mixed to

FIG. 620.

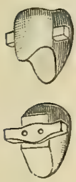


FIG. 621.

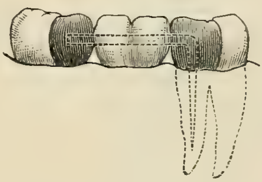
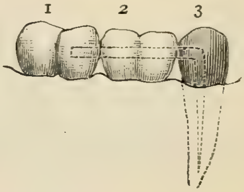


FIG. 622.



a creamy consistency, can readily be applied, and after being held a moment over a spirit lamp is ready to be put on the slide and baked.

Cavities or fillings are usually found on either side of a space made by the loss of a tooth or teeth that will allow the insertion of the ends of the metal bar and the thorough impacting of gold around them. Amalgam can be used in posterior teeth in many cases, or gold crowns penetrated by the bar, as in Figs. 621 and 622.

In Fig. 621, No. 1 is a third molar, pulp alive, with large filling; No. 2 is a porcelain bridge; No. 3 is a first molar, pulp dead, with a metal bar entering the pulp cavity.

* Fig. 620 is incorrect in two respects. The palatine aspect of the completed bicuspid should be a curved line from the palatine cusp to the cervicolabial portion, and not make a saddle over the ridge, as shown in the cut, which would be non-cleansible. The other cut, with a bar riveted on to a bicuspid, should have the bar placed in a groove ground into the center of the teeth, riveting being done to incisors and cuspids only.

In Fig. 622, No. 1 is a second molar, pulp alive, with the crown filling of gold or amalgam retaining the bar; No. 2 is a porcelain bridge; No. 3 is a gold crown with bar passing through crown into root.

Fig. 623 is a view of a bridge of two teeth—a central porcelain crown with a lateral baked into it, the bar and pin being of the same piece, bent at right angles.

In Fig. 623, No. 1 is a porcelain crown forming part of the bridge; No. 2, a bridged lateral with metal bar baked through it; No. 3, a living cuspid with a metal bar running in the center of a solid gold filling.

Fig. 624 is a view of a central incisor bridged on to two teeth whose pulps have been lost.

FIG. 623.

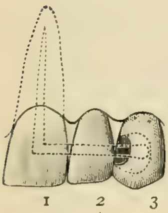


FIG. 624.

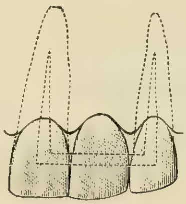
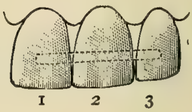


FIG. 625.



As many as six teeth have been inserted in this way on two central roots, and the posterior end of the invisible metal bar running through the six teeth worked firmly into a gold filling in a molar—the six teeth being united on their approximal surfaces by the porcelain running between them at the baking. The backs of such teeth must be given a curved form to insure a cleanly condition.

Fig. 625 is a view of the attachment of the bridge to a tooth standing alone, where the tooth has a gold crown attached, or the bar is worked into a filling. Nos. 1 and 3 are teeth on a porcelain bridge; No. 2 the natural tooth over which the bridge is saddled.

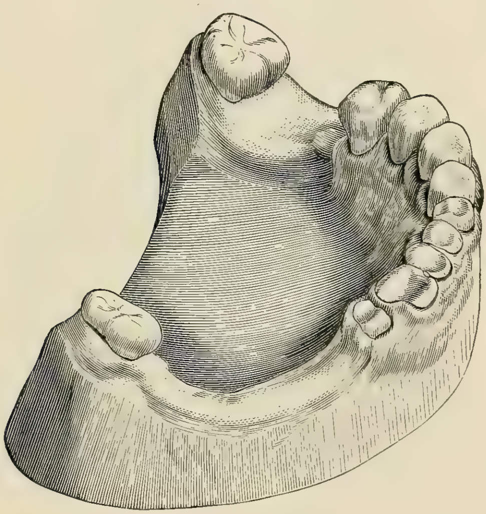
All teeth for this bridge-work should be ground so that no considerable portion of gum would be covered, the teeth just touching the gum by a point only at the cervicolabial portion.

REMOVABLE BRIDGE DENTURES.

As has been intimated, there are operators who prefer bridge dentures that are readily removed from the mouth to any form of stationary fixture. These devices may be made so that the dentist may readily remove them if required either for therapeutic treatment, or for repair; or they may be constructed in such a manner that the patient may remove them for hygienic reasons. We will first consider the system introduced by Dr. R. Walter Starr, whose description is about as follows:

"The case of Mr. W. presented difficulties of an unusual charac-

FIG. 626.

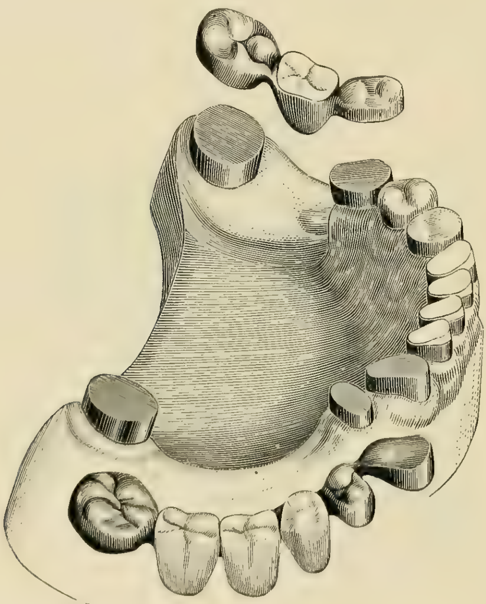


ter, as may be seen by inspecting the illustration, Fig. 626, which renders detailed description unnecessary.

"It will be observed that the molars and the left second bicuspid overhang to a degree that would make the taking of an accurate impression by ordinary methods well-nigh impossible. After a careful study of the case, it was decided that two separate pieces of removable bridge-work should be attempted, and, as an essential preliminary step, the overhanging sides of the molars and bicuspids were ground with engine corundum wheels and points until those sides were made much less inclined, when plaster impressions were

taken, first of one half, and then of the other half of the jaw. Gold cap crowns were closely fitted over the molars, left second bicuspid, right first bicuspid, and cuspid stump. Gold crowns were made to telescope over all the caps, which were then, by means of oxyphosphate cement, fixed firmly on the teeth. Suitable plate teeth were selected, fitted, backed, and waxed in place between the telescoping crowns. After hardening the wax with cold water from a tooth syringe, the pieces were carefully removed, invested, and soldered. The two completed bridges were easily

FIG. 627.

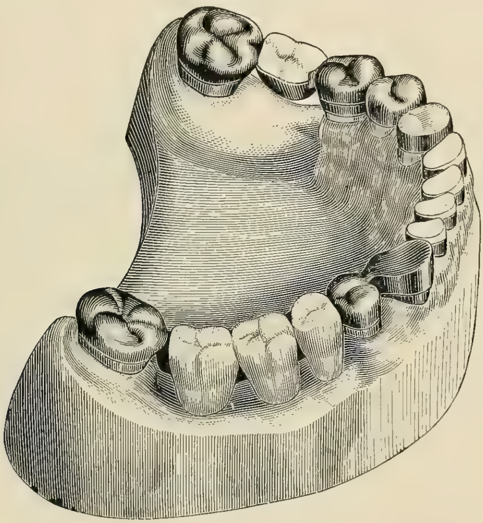


replaced on or removed from the supporting capped teeth, and their appearance when detached is correctly shown by the illustration, Fig. 627, which also shows the capped teeth and stumps. This figure likewise shows the results of the novel method employed in crowning the incisors. Gold collars were fitted tight on the necks of the incisor stumps, and the new style porcelain caps adjusted in the collars, and set in the oxyphosphate cement which had been packed into the collars; thus at the same time fastening the collars on the stumps and the caps in the collars.

"Fig. 628 illustrates the finished crowns and bridges, which latter were secured in position by placing a small piece of gutta-percha in each of the telescoping cap crowns, which were then warmed and carefully pressed in place—the gutta-percha filling only the spaces between the flat tops of the caps of the natural teeth and cuspid caps of the bridges.

"Whenever, for repair or for any other purpose, it shall become desirable to remove one of the bridges, that may readily be done by applying a hot instrument or hot air to the caps to soften the

Fig. 628.



gutta-percha sufficiently to permit the telescoping bridge to be taken off.

"A full upper vulcanite denture was made to replace the old one, which, by improper occlusion, had thrown the full force of mastication on the anterior teeth of the lower jaw, and produced the destructive action that resulted in the deplorable loss of tooth substance shown in Fig. 626.*

"The next case also presented unusual difficulties. The forward overhang of the inferior right second molar was so excessive that an impression could hardly be taken, until with corundum wheels

* *Dental Cosmos*, vol. xxviii.

and points the sides of the tooth had been made parallel, or, rather, slightly tapering, to form a truncated cone, with the neck as a base. The molar was alive and sound, but the crown was gone from the pulpless cuspid, which I suitably shaped by means of my root trimmers (Fig. 629).

"An impression was then taken, the cast from which is illustrated by Fig. 630. A seamless gold collar was, by means of a slightly tapering mandrel, made to exactly fit the tapered natural molar, the lower edge of the collar cut to conform to the gingival margin, a cap piece of gold plate soldered to the top edge of the collar, and a hole drilled through the center of the completed cap

Fig. 629.

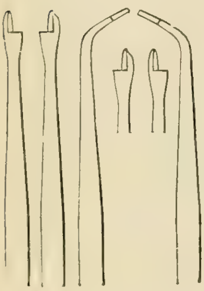
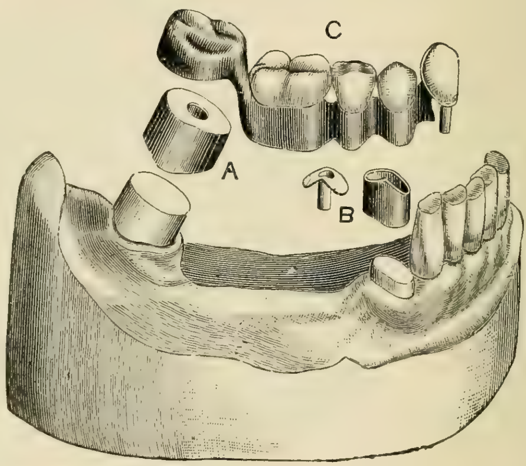


Fig. 630.

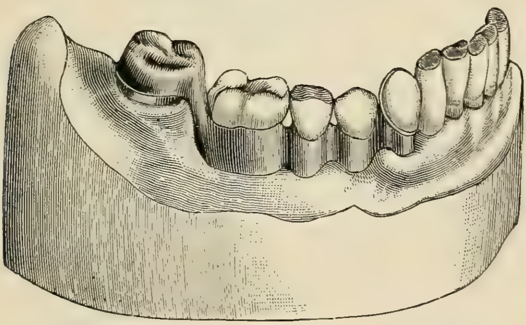


(A). Care was taken to so fit and proportion the cap that it would require finally pretty hard driving to send it home on the tooth; but first there was fitted to the cap a telescoping seamless collar, on which was soldered a gold plate, with cusps, to form a molar crown as shown. The molar was then thoroughly dried, slightly painted with agate cement, and the cap, A, driven hard down with a flat pine stick held upon it and struck with a mallet, the hole in the cap enabling me to see when the cap was quite down. The cuspid was then likewise fitted with a seamless gold collar, the top edge of which was given a roof shape, as seen above the root in Fig. 630. A piece of gold received a corresponding roof shape,

had a short section of gold tubing soldered into it, and was trimmed to the outline of the collar, beside which, B, its form is seen, and to which it was subsequently soldered, after suitable investment to keep the parts in proper place. The root canal had been previously prepared to receive the tube, which, with its roofed cap, was with stick and mallet driven hard down over the root. A piece of gold wire exactly fitting the tube had a roof-shaped piece of properly perforated gold plate slipped over it into position on the root; became fixed in such relation by a drop of melted hard wax; was removed, invested, soldered, and finished in such shape that, excepting the hollowness, it looked like the tube and cap B.

"The relations of the occluding teeth had, of course, been de-

FIG. 631.



termined by an articulating model, and by means of it a series of seamless gold collars and cusp crowns were adjusted on a thin platinum plate fitted on the cast between the cuspid and second molar, and the collars soldered to the plate after investment. The truss thus formed received an appropriate finish by the rounding and smoothing of its basal borders. A plain plate cuspid was backed with gold plate and fitted on the roof-plate, to which, after determining its proper occlusion, it was secured by hard wax, removed, invested, and soldered. It was then put into the tube on the root, the telescoping cap put over the molar, the truss put in position in the mouth, and the whole covered with plaster and marble-dust, contained in a suitable sectional impression-tray, which enabled me to hold the mass steadily in place until the mixture was sufficiently hard to bring away cap and truss and roof-

plate all in proper position. A second mixture of plaster and marble-dust, and a suitable trimming of the first mixture after all was hard, sufficed for the soldering process that resulted in the denture which, when finished, appeared as shown detached at C, Fig. 630, and mounted on the cast in Fig. 631. It went firmly to place in the mouth, and yet was removable in the possible event of accident to the denture, or for readjustment of the cusp crowns, which latter could easily be done by warming the piece sufficiently to soften the gutta-percha, replacing the denture on its anchorages, and directing the proper closure of the occluding teeth."

Dr. Parr's Method.—The following is a method of constructing removable bridge dentures, first described by Dr. H. A. Parr, in the *Dental Cosmos,* vol. xxxi.

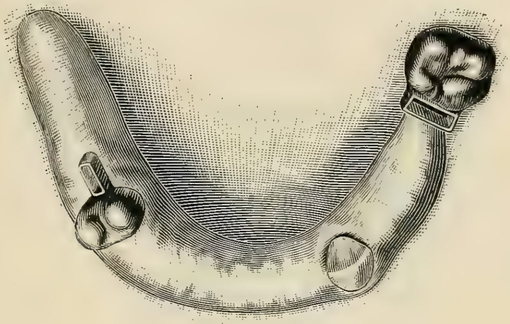
In the construction, adjustment, and placing of a dental substitute, one of the first considerations is its immovability in position, and next its removability for cleansing or repair. The old styles of clasp dentures met these two essential requirements when the forms and relations of the supporting teeth were such that the clasps would firmly embrace those natural teeth and hold the close-fitting plates in position. But the clasped teeth soon became worn or wasted, and in consequence the loose denture lost its efficiency. Even in favorable cases the inverted cone shape of nearly every natural tooth made it a matter of difficulty to secure at the neck near the gum a tight fit of the springy clasp, which, in every instance, must have been large enough to go over the crown of the supporting tooth. Then, too, there was the tendency of the plate to press into the gum and so become loose by carrying the clasp to a yet narrower place on the tooth. In many cases, moreover, the supporting teeth inclined toward or away from one another, and made it well-nigh impossible to construct a plate which could be sprung into place and yet so tightly clasp the teeth as to firmly hold the denture in position.

The object in devising the method of attachment and organization of dental substitutes now to be explained was, as Dr. Parr explains, to avoid the difficulties mentioned, which will be made evident in the following description of two practical cases.

Fig. 632 is from the plaster cast of a lower jaw in which only the lower left second molar, cuspid, and right first bicuspid remained. The molar and bicuspid were fitted with gold cap crowns.

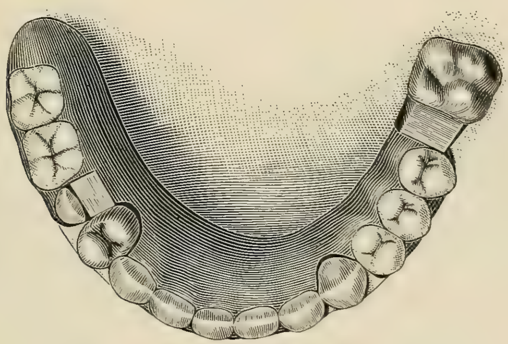
Gold sockets were prepared, and gold tongues, made of strips of spring gold plate having their ends folded upon themselves to form spring catches, were fitted to the sockets. The cap crowns were placed on the plaster teeth, the boxes or sockets hard waxed

FIG. 632.



to the sides of the crowns, and the tongues hard waxed to a piece of stiff wire so that the two tongues could be lifted out of their sockets without breaking either the tongues from the wire or the sockets from the crowns. When by repeated trials this could be done, the crowns and sockets were taken from the cast, invested in

FIG. 633.

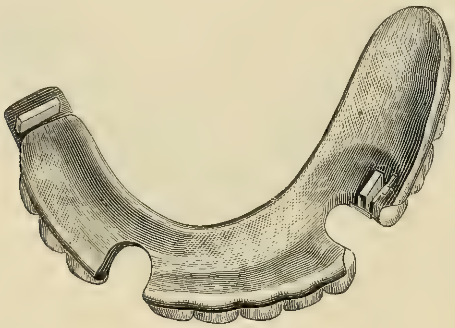


plaster and marble-dust, and the sockets soldered to the crowns. These were replaced upon the cast and appeared as seen in Fig. 632.

The tongues were then placed in the sockets, the artificial teeth

arranged on the cast and waxed up as usual for vulcanite work, taking care that the projecting ends of the tongues were so imbedded in the wax that they would be held firmly when the piece should be removed to be flasked. It is, in fact, best that at the outset the tongues should be soldered to a stout gold wire bent

FIG. 634.



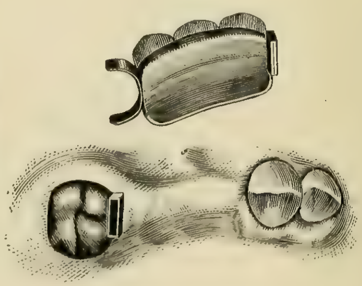
to fit the cast, so that the wire will stiffen the waxed-up piece, and also hold the tongues more securely in the piece during and after vulcanization.

Fig. 633 shows the vulcanized denture in place on the cast.

The under side of the denture is shown in Fig. 634, which also makes evident the forms and relations of the tongues which hold

FIG. 635.

FIG. 636.



the denture in place. The parallelism of the tongues permits their ready removal from their sockets, no matter how much awry the supporting teeth may be. The bearing of the denture upon the cap crowns admits of the contact of the denture with the gum on which it rests but cannot be pressed into because of the

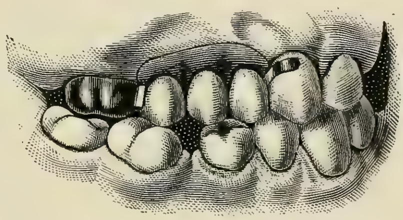
cap crown supports. The original denture, of which this is a duplicate, is now in satisfactory use.

Fig. 635 represents the articulated cast of a case for which a similar tongue and clasp vulcanite denture was made. This is illustrated in Fig. 636, which needs no description. Fig. 637 shows the denture in place, the original having been made for and placed in the mouth of a patient exhibited at the clinic of the Odontological Society of Pennsylvania, at Philadelphia, in December, 1888.

These are simple examples of a class of work having a wide range of application and capable of construction without the trouble and cost of all-gold plate-work.

The sockets and spring tongues require some skill and nicety of workmanship to insure a close fit of the one in the other so that the attachment shall be firm, yet capable of easy-designed detachment for cleansing or repair.

Fig. 637.



A notable advantage of this mode of constructing dentures for the upper jaw is manifest in the fact that the surface of the plate which rests upon the gums need only be wide enough to cover the ridge, and thus avoid the common interference of artificial dentures with the function of speech.

Dr. Davenport's Method.—The following method of constructing partial dentures, described by Dr. J. L. Davenport in the *Dental Cosmos* is an amplification of the principle of attachment involved in the process just considered.

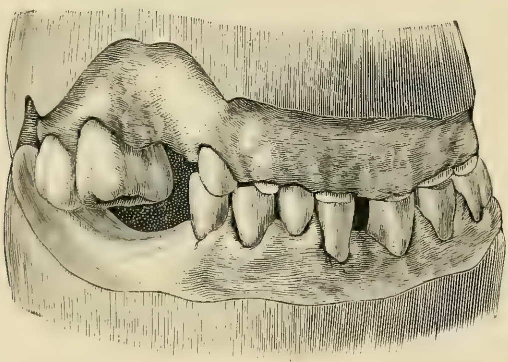
The case treated was one where the only teeth remaining in the upper jaw were the six front teeth, the three molars on the right side, and the first bicuspid on the left. The crowns of the front teeth were wholly obliterated from excessive attrition consequent on the loss of the occluding back teeth, necessitating the exclusive use of the former in mastication, as shown in Fig. 638. The shorten-

ing of the lower teeth, resulting from the same cause, was remedied by building them up to a uniform height with crystal gold, Fig. 642, the vacuities in the lower jaw resulting from the loss of the left central incisor and several of the back teeth being supplied with substitutes in the manner hereinafter described.

For this case, what is termed a "combination plate and movable bridge" was constructed, and is thus described:

"The two superior cuspid roots were dressed down nearly to the gum and fitted with 22-carat gold cap crowns, similar to those described by Dr. J. Rollo Knapp. After these had been placed in position, a hole was drilled through each cap of a size suited to that of the pulp canal, and a tube of iridium and platinum was ad-

FIG. 638.



justed in the root cap and waxed in position. The cap and tube were then taken off and soldered, great care being taken to have the tubes enter both roots perfectly parallel. These were permanently secured in the roots with gutta-percha, and to prevent the caps being pulled off, the top of each tube was slit down a trifle, and after insertion was bent back into the gutta-percha with a warm instrument.

"The incisor roots having been dressed down even with the gum and filled, a plaster cast was taken and a narrow 20-carat gold plate was swaged to fit over the ends of the incisors and the capped cuspids, making it a little broader where it had to rest on the gum back of the first left bicuspid root. A hole in the plate was then made to expose the root of the first left bicuspid. This was fitted

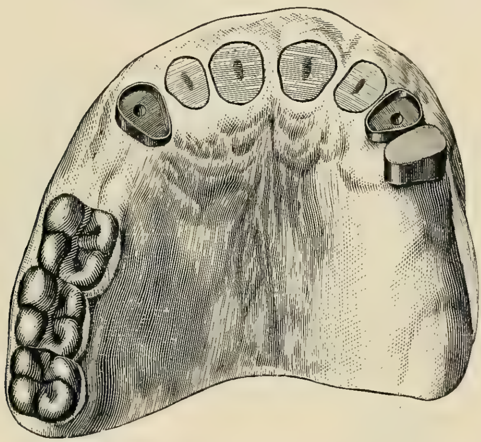
with a bifurcated iridioplatinum pin, having notched sides, and a hammered head upon its lowered end, which came down below the root about ⅜ of an inch.

"A thin iridioplatinum band was then made to encircle the root, passing just under the gum and being slightly longer than the headed pin. This band was perforated with two rows of holes, from without inward, giving the inner surface a roughness similar to that of a nutmeg grater. The band and pin were then made secure to the root with a non-shrinkable copper amalgam.

"Fig. 639 shows the upper jaw ready for the plate.

"I must mention here that this method of lengthening the bi-

FIG. 639.



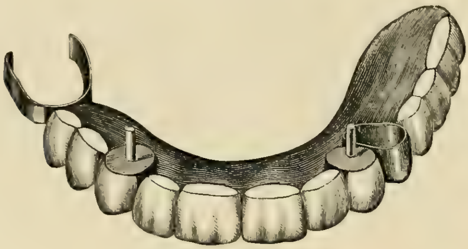
cuspid is not original with me, but has been previously described by Dr. E. Parmly Brown. I have, however, used this method several times on very frail roots, and cemented over it a gold cap crown.

"In the present case, after the amalgam had become hard and the end and sides had been polished, a gold crown was fitted over all just up to the margin of the gum, and in close contact with the end of the band and amalgam. This crown was loose enough to admit of its sliding on and off, though with just enough friction to hold it in place when at rest. This gold crown was then placed in position, the plate also inserted, and hard wax used to firmly join the two in the mouth. They were then removed and soldered.

"Gold pins were then placed through holes drilled in the plate into the tubed cuspids; then soldered to the plate, the pins being of a size to fit the tubes accurately. The plate was also provided with a wide clasp encircling the first molar on the right.

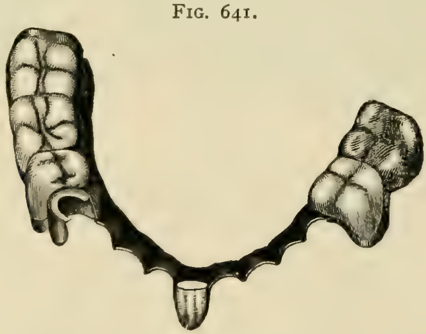
"The plate was then provided with a gold bar about ⅛ of

FIG. 640.



an inch wide, occluding perfectly with the lower teeth, and plain teeth soldered in place, hiding the bar, and just meeting the gum in front of the incisor roots. The plate rested squarely against the capped cuspids, each of which showed a narrow band of gold when the plate was in position. As finally completed (see Fig. 640) this was the most perfectly fitting piece I ever inserted,

FIG. 641.



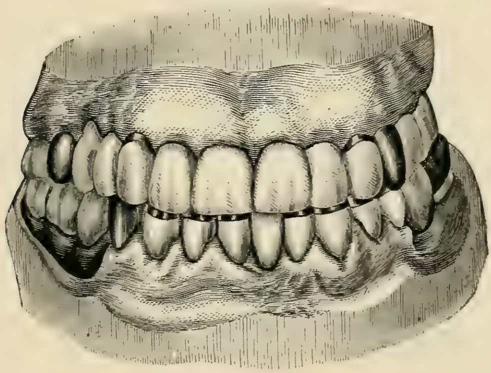
requiring great care in its removal, and yet by a little practice the gentleman was able to remove and replace it quite easily. It was also as firm as any permanent bridge could have been, though it had no support on the left side back of the first bicuspid.

"The lower jaw was supplied with a double 20-carat gold plate, having a wide clasp on the first right bicuspid, which, after being

built up, presented a cone-shaped top, about which the clasp fitted so as to rest firmly upon the end of the tooth, thus preventing injury to the gums during mastication.

"The only peculiarity was that the second left inferior molar, being abnormally short, though well-formed and standing upright, was fitted with a wide clasp, extending about ⅛ of an inch about the tooth, and a piece of gold plate with gold cusps was soldered into its clasp, covering the molar crown and occluding with the molar on the upper plate. (See Fig. 641.) This not only prevented the plate from being bitten down unpleasantly on the gums during mastication, but enabled me to use a shorter molar upon the upper than I otherwise could have done, and better al-

FIG. 642.



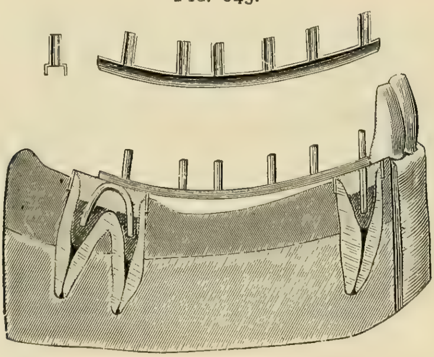
lowed the antero-posterior and lateral movements of the jaws. The case as completed is shown in Fig. 642."

Detachable Bridge by the Mandrel System.—A description of two or three methods of constructing detachable bridges by the mandrel system will suffice to indicate the general principles involved. Having these, each operator will find it an easy task to devise the modifications necessary to adapt a method to individual cases.

The first method is especially applicable to cases where both ends of the bridge are attached to roots, as, for example, the inferior cuspid and second molar roots of the left side, the intervening teeth having been lost. The operation is conducted as described in the first case of fixed bridge-work down to the construction of

the truss, for which in this method square gold wire is used. Having cut the wire to the proper length, lay it upon a piece of gold plate (about No. 26, American gage) of the same length and full three times as wide, and, placing the two upon the lead anvil, with a hammer and the piece of file before used drive them into the lead. This will form the plate into what we may call an open trunk, which fits the square wire. Remove the two from the lead together, and, without separating them, curve to the proper shape to form the truss. Grind crowns having vertical holes, like the Bonwill, to fit, and having determined the proper points for the supporting pins, drill through both trunk and bar at these points. Separate the bar from the trunk, and fit and solder pins to the bar. Construct small tubes to fit the pins, ream out the holes through the trunk to admit

FIG. 643.



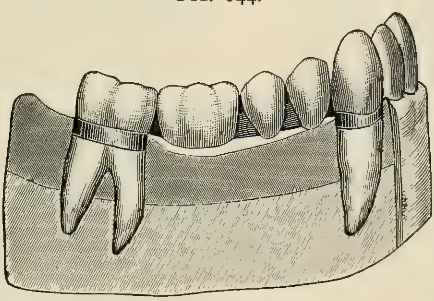
them, and set the tubes with solder in the enlarged holes (Fig. 643). Fix the crowns permanently upon the tubes. They may be mounted in any of the approved ways, by vulcanizing or by the use of a plastic filling material. When they are firmly set, place the trunk with the teeth upon the bar and anchor it permanently as already described. Fig. 644 shows the completed work.

"In this method the truss consists of the bar and the open trunk which covers three sides of it. The bar is, of course, permanently attached to the roots of the molar and cuspid, but the trunk with the teeth can be removed at any time.

"The second method of constructing a detachable bridge is applicable to cases where one or both of the supports or piers are sound teeth. In the case adduced for illustration, the right inferior

cuspid crown was decayed, and both of the bicuspids and the first molar were absent. The supports for the bridge were the sound second molar and the cuspid root. After the cuspid root was prepared and banded, the crown of the molar was reduced very slightly, not sufficient to destroy the enamel, but just enough to permit a collar properly fitted to pass over it. A collar somewhat wider than the length of the crown from grinding surface to neck was fitted and cut to the proper width. Two lugs were then soldered upon the anterior and posterior sides and bent to fit into the approximal fissures, which were slightly cut out to admit them. An impression was taken, the collar coming away in the plaster, and a cast was made with the collar in position. A coned tube was then made for the root of the cuspid and a coned pin fitted into it. A

Fig. 644.



truss of half round wire was made, to which the collar, coned pin, and the molar were next soldered (Fig. 645). A half-clasp to grasp the lateral was next soldered to the end of the truss, to be supported by the cuspid. The object of this clasp was to guard against the teeth being thrown out of proper alignment by the force of mastication. Bonwill crowns were then vulcanized to the truss, after their supporting pins had been fitted and soldered to it. (Countersunk crowns can be used as well in the same way. Plain plate teeth may also be used in this style of work, in which event they are to be soldered to the truss.) The bridge was then ready to be set, which was accomplished in the following manner: The cuspid root was nearly filled with oxyphosphate, and the coned tube was placed upon the pin. The band was put on the molar, and the coned pin, with the tube upon it, was forced into the plastic in the

cuspid root. As soon as this became set, the tube was held permanently, while the bridge itself could be removed whenever desired (Fig. 646).

"This method of fixing the tube allows considerable range in its adjustment. In soldering the coned pin to the truss, care should be taken to set it at an angle exactly parallel to the axis of the molar; otherwise there will be difficulty in removing the bridge.

Fig. 645.

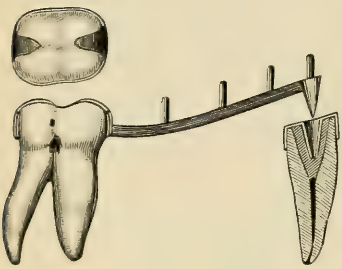
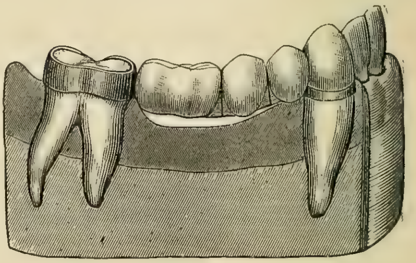
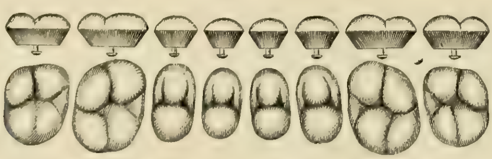


Fig. 646.



"The third style of detachable bridge-work to be described involves the use of cusp crowns (Fig. 647) for supporting posts or piers. Suppose a case similar to that just described, where a bridge is required to extend from the right inferior cuspid to the right inferior second molar, with only the roots of the two teeth named as supports. Prepare the roots and pulp chamber. Set screw-posts into the dentine for anchorage, or as retaining pins, and

Fig. 647.



fit the collars, using sizes wide enough to form the walls of the crowns. Fill the pulp chamber and about two-thirds of the depth of the collars with a plastic filling material, packing it well around the retaining posts. Select suitable cusp crowns for the molar and cuspid and place them in the ends of the bands to ascertain the occlusion. If too long, shorten the cusps or reduce the bands with engine corundum wheels, and when the correct articulation is found

form a small square shoulder in the lingual edge of the cuspid and in the posterior grinding surface of the molar. Fill the remaining portion of the collars with plastic mixed somewhat thinner than the first lot, and set the cusp crowns in position. If there are antagonizing teeth, the mere closing of the patient's jaws will force the crowns to place. If there are no antagonizing teeth, the crowns can be readily tapped to place with the mallet, using a piece of wood as a driver. Allow the filling material to set firmly, trimming off any excess which may exude around the collars. Bridge supports or piers constructed on this plan are strong and durable, and likely to withstand any strain. Take an impression and proceed to fit seamless collars to telescope over those already set upon

FIG. 648.

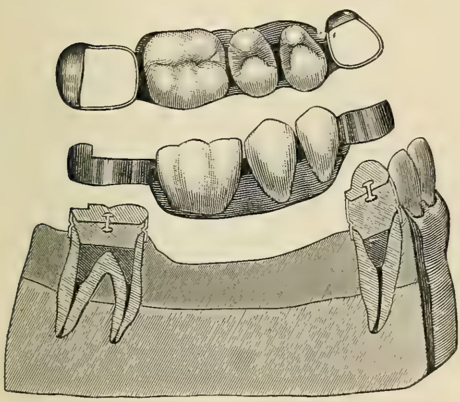
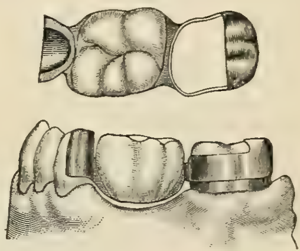


FIG. 649.



the cuspid and second molar roots. It will be remembered that these collars are so made that each size telescopes into the next higher series. If the proper sizes are selected for the outside bands, the work of fitting is readily and quickly accomplished, forming tubes which slide easily over the supporting piers, and at the same time fit closely. It is only necessary to take care in shaping the tubes not to drive them too far up on the mandrels, and thus stretch them so as to destroy the fit. To the outer end of each of the tubes solder a small piece of gold plate, forming partial caps so placed as to rest when in position upon the shoulders previously cut in the cusp crowns. Adjust a truss bar of half round gold wire, to the ends of which solder the tubes (Fig. 648). The truss is now ready

for the teeth, which may be of any of the forms used for this purpose, and they may be attached to the bar in any way desired. One of the strongest attachments is vulcanite.

"An easy modification of this plan is readily adapted to cases where only a small space is to be filled and one end of the bridge is to be supported by a sound tooth. Thus, suppose it is desired to bridge a space formerly occupied by the two inferior left bicuspids, the crown of the first molar being a mere shell. The operation would be essentially the same as in the previous case, except that the sound cuspid would be utilized for one of the piers, as follows: Fit a seamless collar, cut out a portion of it so that it will embrace only about two-thirds of the cuspid crown, and solder a partial cap or cover to it (Fig. 649). Or, the cuspid crown may be separated from the lateral incisor with a diamond disc and the collar allowed to embrace the whole crown.

"The great desideratum in constructing a piece of bridge-work is, of course, the securing of perfect usefulness in mastication and speech, combined with absolute comfort and cleanliness. The closer a bridge approaches that condition where its wearer loses consciousness of its presence in his mouth, the nearer perfection it is. Scarcely less important, however, is the necessity of providing for repair. Accidents will occur, and the system which superadds to usefulness, comfort, and beauty, ready facility for repairing breakages, is by so much superior to those which make no such provision. The place of a crown broken from a bridge constructed by any of the methods above described can be easily supplied, and the piece when repaired will be as strong and serviceable as it was originally."

Dr. Condit's System.—The method devised by Dr. A. S. Condit is the combination of removable plate with gold or Richmond crowns, which are cemented upon the natural teeth or roots, contiguous to the space to be filled with the artificial substitute. The plate is made to rest upon the gums, and held firmly in place by means of an attachment, part of which is placed upon the crowns and a part in the plate.

The construction of the attachment is such that when the work is in place it cannot be detached except by a straight up or down pull, nor can there be any lateral movement. It is also claimed to have sufficient tension to hold the work securely in place, yet not so firmly but that it can be easily removed by the patient.

By the use of this method the natural teeth are sealed up and protected from the attrition of the plate, and they are held firmly in their normal position and, Dr. Condit says, are not moved out of line during mastication.

A prominent feature of this work is that the bearing is supposed to be equally divided between the teeth attached to, and the ridge.

Figs. 650 and 651 represent the loss of the lower incisors. The advantage in using the method for such cases is that the cuspids are held firmly in their normal position and undue pressure is released from the gums.

If the ridge had to bear the entire weight of the plate, the gums would soon be pressed away from the cuspids, and the teeth would move out of line.

In upper cases, where bicuspids and molars have been lost on

Fig. 650.

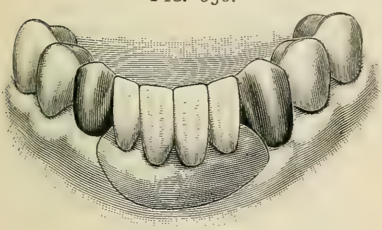
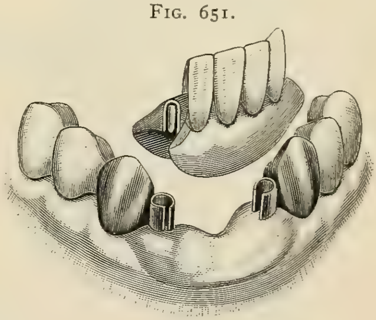


Fig. 651.



both sides, as shown in Figs. 652 and 653, the work can be constructed by connecting the sides with a narrow plate across the center of the palate, or by skirting the anterior teeth with a narrow strip of plate, and the same object be accomplished as when the entire palate is covered.

This method is considered by Dr. Condit to be applicable in one-attachment cases, such as are shown in Figs. 654 and 655. He suggests, however, that in making this appliance a small, soft-rubber washer should be placed over the pin in the attachment, so that the greatest strain should be brought upon the ridge, the attachment merely giving it stability.

The directions given by Dr. Condit for the construction of this class of denture are about as follows:

One-attachment Case.—First fit a gold cap crown to the tooth,

contiguous to the space to be occupied by the piece, with the same accuracy as for an ordinary bridge. When in place, mark with a

Fig. 652.

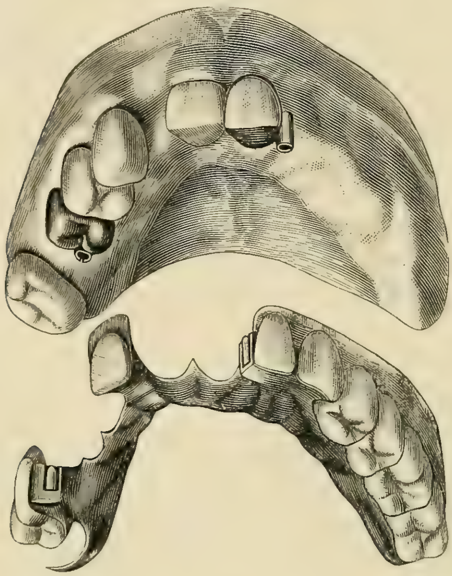
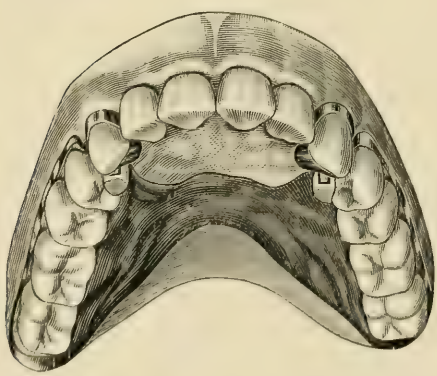


Fig. 653.



sharp instrument the position for the tube (1, Fig. 656), which should be at the posterior lingual side, far enough from the buccal to avoid interference with the artificial teeth, and yet not so far as

to make an undue prominence on the lingual side. The crown or band is now removed from the mouth and the tube (1, Fig. 656) attached with 18-carat gold solder, using no more than just sufficient solder to hold it securely. To properly do this the tube should be placed on one point of a pair of soldering pliers, with the *open side out,* as shown in Figs. 658 and 659, and held as nearly vertical in its relation to the crown as possible. If the crowned tooth leans to the one side or the other, so that it is necessary in giving the tube its vertical position to stand it away from the crown at either the coronal or gingival ends, it may easily be accomplished by bending the points of the pliers out or in, as is clearly shown in Figs. 658 and 659. The tube now being soldered in

Fig. 654.

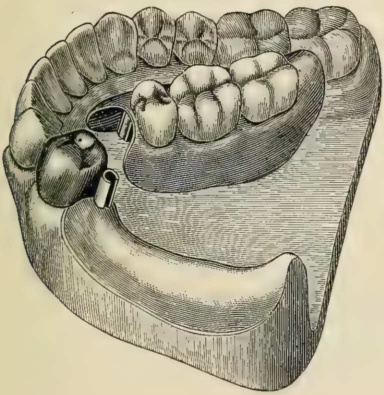
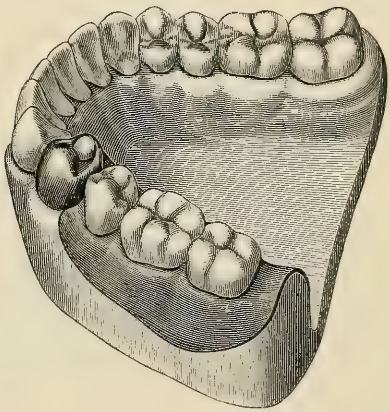


Fig. 655.



place, should be spread very slightly by passing a round instrument through it—to allow the pin and shield (Fig. 656) to slip easily on and off—and the crown or band returned to the tooth with the pin and shield in position.

If the articulation is interfered with, the tube may be dressed down from the coronal end, and the pin and shield correspondingly ground off from the gingival end, repointing the pin by carefully running a small pear-shaped bur around between it and the shield.

The crown or band should now be *cemented* to the tooth and the cement allowed to thoroughly harden, when the pin and shield are again placed in position and the bite and impression taken. Be sure to take the bite before taking the impression.

If the pin and shield do not come away with the impression they must be removed from the tube and carefully placed in proper position in the impression, which should be varnished or otherwise prepared for pouring the model. Before pouring, however, the long tube (Fig. 657) is filled with plaster and slipped over the pin in the shield, the lug (A) projecting from the open side of the shield. This long tube prevents any possible displacement of the shield after the model is poured, and the filling with plaster prevents the vulcanite from filling the shield.

The model is now poured in the usual manner and placed on the articulator; teeth arranged, flasked, and finished as in any ordinary denture—except before packing the vulcanite, the point of the lug (A) attached to the shield (Fig. 656) may be bent slightly, in such wise as to give it firmer hold in the plate. After vulcanizing, the tube

Fig. 656.

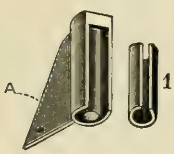
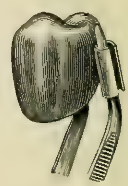


Fig. 657.

Fig. 658.

Fig. 659.



(Fig. 657) is removed from the shield and the piece finished. Pinch tube (1, Fig. 656) on the crown very slightly and adjust the work.

Two-attachment Case.—The proceedings are identical, except in the matter of attaching the tubes to the crowns or bands. In these cases the crowns are properly fitted and placed upon the teeth selected for attachments. Then an impression must be taken and the crowns removed from the teeth and placed in their relative positions in the impression and a model made. (Wooden cores about ½ of an inch in length may be fitted rather loosely in the crowns before pouring, to permit their easy removal from the model.)

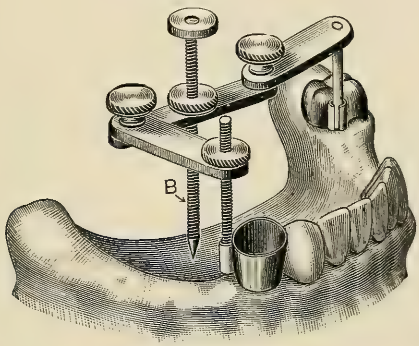
After the model is secured, crowns in place thereon, the guide (Fig. 660) is adjusted with reference to the proper placing of the tubes (1, Fig. 656), as directed in the one-attachment case, and fixed with the set-screws. (One post of the guide is adjustable to allow for any variation in the height of the crown.) The tubes are now placed upon the ends of the guide posts, with the *open*

side away from the crowns. The screw (B), Fig. 660, is run down until the point touches the model, when a little melted beeswax dropped at the point will hold the whole in position until the tubes (1, Fig. 656) are waxed with *hard wax* to the crowns. After which the center screw (B), Fig. 660, may be carefully turned to the left, releasing it from the wax, and the guide may be removed from the tubes. The crowns are then removed from the model, invested in plaster and sand, and tubes soldered.

In cementing the crowns on the teeth, in the mouth, before the cement hardens, it is well to remove the center screw from the guide and test the tubes to be sure that the crowns have gone back exactly to their proper places on the teeth.

Attachments for Porcelain Work.—The crowns and attachments

Fig. 660.



are made and adjusted in the manner just described. After cementing them to the teeth, *platinum* shields, the same as Fig. 656, lacking the lug A, are placed over the tubes and impression taken. If the shields do not come away with the impression they must be removed and placed in their proper places therein.

Pour your model now with the view to making metal dies for swaging.

The plate must be swaged to fit with the utmost nicety around the shields and teeth.

If several teeth must be skirted, to give the requisite strength an extra piece of 28 gage platinum should be swaged and soldered to the plate with pure gold.

After swaging, remove the shields from the model and place

them in position in the mouth; then try in the plate; if swaged to a proper fit, take impression with plate and shields in position. If they come out with the impression, a *platinum* tube, the same as Fig. 651, is placed in the shield and a plaster and sand model is poured. When separated, solder the shields to the plate, using pure gold solder, and again try in the mouth. If care has been exercised in every detail, the plate must fit snugly, when wax may be inserted and the bite secured. Remove the wax and plate together; tack asbestos fiber, soaked in water, into the shield until filled; then place on the articulator, and proceed as in the case of any ordinary continuous-gum piece.

Attachments for gold work are made identically as described for porcelain above. The shields for gold work are made of 20-carat gold, soldered with 20-carat solder. Thus the gold attachments made for *vulcanite work cannot* be used in connection with gold plates, as the shields are of 18-carat gold, the pins 16-carat, and soldered with 14-carat solder.

Attachments for cast aluminium are made exactly as for vulcanite, described above, using, however, the platinum shields.

Dr. Carr's Method.—A system of making anchored, adjustable, and removable dentures was devised about six years ago by Dr. C. M. Carr, of Salt Lake City, Utah. In describing his work he says: "I have adopted the name 'anchored, adjustable, and removable denture,' because it better fits the work than either 'plate' or 'bridge.' While the method partakes partially of both bridge- and plate-work, yet it is neither of them, the palate never being covered and the teeth or roots used for anchorage having no excessive pressure or lateral strain placed on them. There is, however, a light and yielding pressure placed upon the roots during mastication—an intermittent pressure, which nature seems to require to sustain a healthy union between any root and the alveoli. This intermittent pressure is imparted by the little spiral spring, which is the secret of my method, everything else being employed to accommodate it."

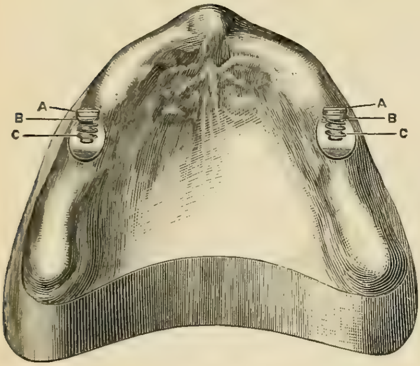
In illustrating this form of denture we have selected an extreme case, one where other forms seem almost barred out. It is a facsimile of a case now being worn by a lady in California. The mouth was such that an adhesive plate was not very successful, and it was a great desire of the patient to have the palate free and unencumbered, as is frequently the case with speakers and singers.

All the teeth having been lost, the first thing done was to implant two roots, one on either side, in about the center of the ridge. These roots, however, were prepared for the reception of the posts, and filled with gutta-percha before being implanted. After the roots became thoroughly attached, an impression was taken; the imprints of the roots were enlarged about $\frac{1}{16}$ of an inch in same before the cast was run. This is done so that the roots will appear larger on the cast and die, both in height and breadth, and when the saddle or base (Fig. 662) is swaged and placed upon the ridge in the mouth there will be a space between the chambers on the roots and the roots themselves. This being accomplished, a little warm wax was placed in these chambers and the saddle pressed firmly into position against the gum tissue. In this way the exact location (by impression of the end of root in wax) of the tube in the root is secured. Then, with a plate punch, a hole is made in the exact center of the impression of the end of tube, after which two other holes are punched, one on either side of the first, or center one; then with a fissure drill on the dental engine cut the three together, making a slot, as shown on the left side of Fig. 662, through which the **T** head of the anchorage stud (A) will pass. Then, as it is necessary to prevent the **T** head of stud A from rotating or moving during mastication, and thus releasing the denture, a segment of a disc is soldered on each side of the slot, as shown at H in Fig. 662, and a cross-cut filed, with a very small round file, directly across these two segments at right angles with the slot. It is in this small cross-cut that the **T** head, the under portion of which is half-round, will rest when the denture is in position.

The next step is to secure the *outer* tube, with lid at top for closing same (F, Figs. 662 and 670), in the exact location for the free working of the adjusting stud (A). After this is located correctly and soldered in position, the saddle is ready to receive the teeth.

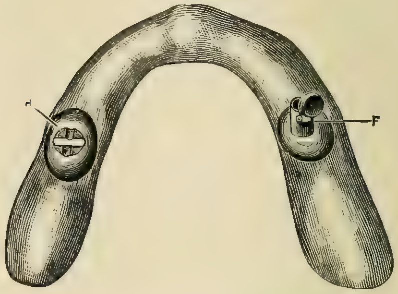
For this purpose place the saddle (Fig. 662) in the mouth, and with a key (Fig. 672) rotate stud A one-quarter turn in tube (F), and the **T** head will stand directly across slot and rest in cross-cut H (Fig. 662), thus locking denture securely against the gum so far as any liability of being thrown out of position is concerned. And yet these roots beneath are not in actual contact with the saddle, the counter-

Fig. 661.



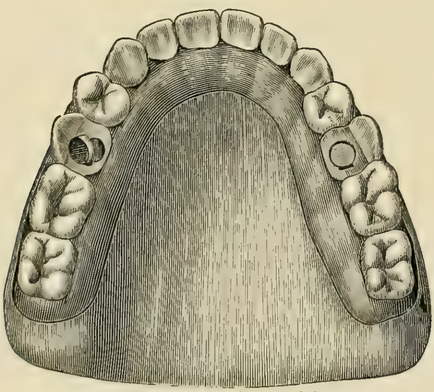
Cast of upper jaw ready to receive the denture.

Fig. 662.



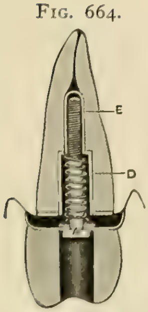
Saddle formed to receive teeth for upper denture.

Fig. 663.



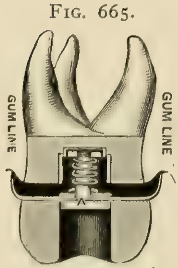
Upper denture in position.

Fig. 664.



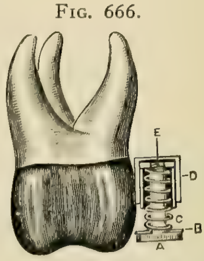
Straight root attachment in position.

Fig. 665.



Transverse section of molar root attachment in position.

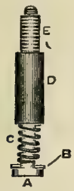
Fig. 666.



Third molar attached where there is no occluding tooth.

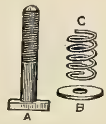
sunk chambers leaving a space over and around hem. The saddle is now between the little washer B and the **T** head A, Fig. 667; the spring C is under the washer B and encircles the shaft of the stud in the root down to the threaded portion (see Fig. 668) and rests on a shoulder in tube between E and D. Now, during mastication the gum still admits of some motion of the denture, it being of a soft and

Fig. 667.



Single straight root attachment.

Fig. 668.

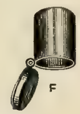


Adjusting stud, spiral spring and washer.

Fig. 669.

Molar root attachment.

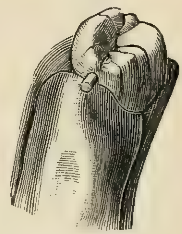
Fig. 670.



Tube with spring lid.

yielding nature, so that when there is any pressure placed on the piece the spring beneath is compressed slightly, imparting a light and yielding pressure to the root or roots beneath. This intermittent pressure seems to be what nature requires to sustain a healthy union between the roots and the process. Without the spring there would not be any pressure on the roots at any time, and the weight of the denture would eventually draw the roots from their sockets, until the denture would come in contact with them during mastication, after which the pressure of mastication of the whole case would be on the roots, which nature would never tolerate.

Fig. 671.



Posterior end of saddle, held in position against gum by means of platinized gold pin set into the tooth or filling.

The case completed and in position is shown in Fig. 663.

In attaching this system to a first molar root, Dr. Carr describes his process as follows: "In this case we must utilize breadth in place of depth to accommodate the attachment. The *spring* is what we wish to accommodate. Now, the root being found in position and the second molar missing, we grind the root down until it just stands flush with the gum; then chamber out to near the bifurcation of the roots, making the chamber of considerably larger diameter

than for the other form (compare Figs. 664 and 665). A piece of gold plate covers the end of the root the same as in the other case, with larger hole through same. In this hole is placed an internally threaded tube, adapted to engage another externally threaded tube or cup; for one end of this second tube is closed, and in the center of this closed end is soldered the adjusting stud with washer encircling same next to **T** head, A. The spring interposed between washer and bottom of cup (Fig. 669) imparts the intermittent pressure as in the other form of attachment. Now this same form is used for wisdom teeth attachments where there is no occluding mate and it becomes necessary to impart an artificial pressure to overcome gravity. In this case it is either anchored in a large approximal filling or soldered to a gold crown. (See Fig. 666.) The most common case to be met with is the pin in a molar left protruding to engage the posterior end of the saddle; this is the form that is applicable to all molar cases except as stated above, viz., no occluding mate, or sixth year molar root found in position with twelfth year molar missing. In all molar cases of the attachment where it does not become necessary to impart any artificial pressure, a simple pin attachment is all that is necessary." The washer, B, is used to compress the spring or to prevent the spring from working through the oblong slot in saddle, through which the **T** head of stud passes in removing and replacing the case, which is done daily by the patient wearing the case. To adjust it to any desired pressure against the ridge the adjusting stud is simply rotated one way or the other until the desired position is secured. The key, Fig. 672, is to be given to the patient for manipulating adjusting stud at will. Dr. W. J. Younger of California, who has had personal experience with this form of denture, says of it: "I could not for a long time believe it was of such broad and universal utility."

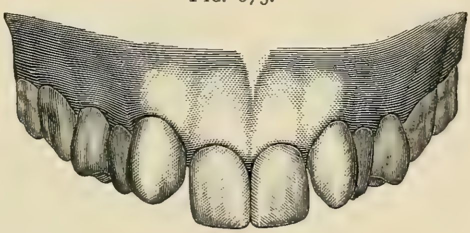
Fig. 672.

Key for manipulating adjusting stud.

METHODS OF CONSTRUCTING CROWNS AND BRIDGES IN CASE OF IRREGULARITY.

A young lady of about twenty-two years called upon the writer for services. Her mouth presented a very homely appearance, which was largely due to the ignorance or lack of judgment upon the part of her dentist in former years. The history of her case can be given in a few words. It is a characteristic of her family to have large, strong teeth, with the cuspids quite prominent; but in her mouth these teeth were so prominent as to disfigure her, and when she commenced to grow into womanhood her mother took her to their dentist to have the irregularity corrected. This gentleman, as I have said, through bad judgment extracted the two lateral incisors, and allowed the cuspids to come down and forward to

Fig. 673.



partially take their place. Then the mischief was done. The mouth was given a very coarse appearance by the large teeth being brought so near the center, and as they did not entirely fill the space, an ugly opening was left between these teeth and the central incisors. (See Fig. 673.) When the lady consulted me, it was with the idea of having the cuspids extracted and two smaller teeth inserted upon either side; it was her wish at the same time to have it done, if possible, in some way, so that she would not have to wear a plate. After studying her case it was, therefore, decided to extract, not the cuspids, but those teeth which should have been removed in the first place—the first bicuspids. Then with suitable regulating appliances the angle of the cuspids was corrected and they were drawn back so as to partially fill the space formerly occupied by the first bicuspids; at the same time the second bicuspids were brought into line, and all secured with retaining appliances, which were

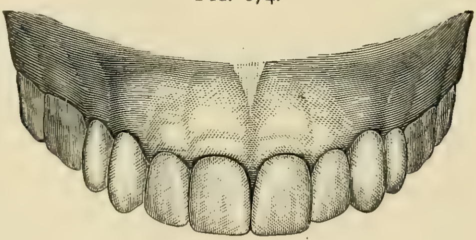
worn for several weeks. A lateral incisor was then prepared for either side, and inserted by means of plate and pin bridges. Described by Professor Litch on page 565.

The result obtained was exceedingly gratifying, a fair idea of which is shown in Fig. 674.

Another case is one treated by Dr. I. N. Broomell, who contributes the following description:

"The superior cuspid was fully ¼ of an inch out of line; standing inside the arch to such a degree that a casual glance at the patient would lead one to suppose the tooth was missing. It was also imperfectly developed, so that, had age and other circumstances favored its restoration to the proper position in the arch, its malformation made it inadvisable to attempt such an operation (Fig. 675). The patient being desirous of having the deformity

Fig. 674.



remedied, at least so far as appearances were concerned, I proceeded to do so in the following manner: Grinding off the irregular prominences of the tooth, I made it more perfectly conical in shape. After securing an impression of the deformed tooth and casting zinc dies, I swaged a hollow gold cap to accurately cover the whole surface and extend slightly under the gum. This added thickness of gold, when placed over the tooth, extended the labial surface to about what should have been the palatal line; thus permitting me to adjust, by grinding and filing, a porcelain tooth with its backing to the cap. These were soldered together and the appliance secured on the cuspid by oxyphosphate cement. In this case no pins were used, the cap alone being sufficient to hold the denture in position. (A, Fig. 675.) It has now been in the mouth some three or four years, during which time I have removed it several times in order to be satisfied that all was right under the

cap. In fact, I consider that, when it is at all possible to do so, all appliances of this order, including small pieces of bridge-work, should be so constructed that they may be removed from time to time, thus affording an opportunity to detect any carious conditions.

"Another case which I will briefly present was somewhat similar in construction to the one just described, but was inserted under different circumstances. For some reason unknown to the patient, he had lost from a lower incisor the entire labial surface, extending from the cutting edge to the gum margin, and somewhat below it. The lingual half of the crown remained, and fortunately the pulp was not exposed (Fig. 676). With a corundum wheel I ground

A FIG. 675.

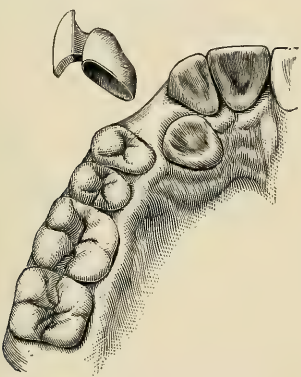
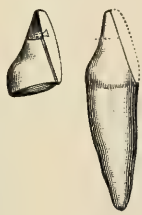


FIG. 676.



off the cutting edge of the tooth, to the horizontal dotted line seen in the illustration, until it was below the line of the pins in the porcelain tooth, which had been selected because its cross-pins were near its cutting edge, and ground the porcelain tooth to fit the inclined surface of the natural organ. I then fitted a backing of very thin platinum, allowing it to extend over the whole back of the porcelain tooth, including the inclined surface. After making a cap to perfectly fit the lingual surface of the incisor, I pressed it around the sides until it could be soldered to the backing, thus making a cap (A, Fig. 676) which completely covered the abraded tooth, oxyphosphate cement being used in setting the denture."

BRIDGE-REPAIR.

The greatest annoyance which bridge-work is likely to cause patient or operator is the occasional breaking of a porcelain facing. One of the most secure and artistic methods of repairing such a break is that devised by Dr. E. A. Bryant, and is illustrated in Figs. 677, 678, 679, and 680.

His method is as follows: Select the facing to be attached, color, size, and shape to suit, grind or clip off the pins extending out from the space from which the original facing was broken from the bridge, and smooth this space so as to present a flat surface. Drill two holes through the backing of the bridge for the reception of the pins of the new facing to be attached, and as near the size of the pins as possible. With the countersink bur in the right-angle hand-piece, countersink from the inside until the bur comes

FIG. 677.

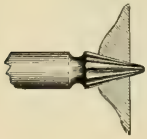


FIG. 678.

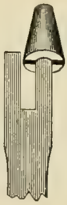


FIG. 679.

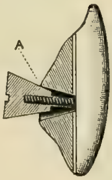
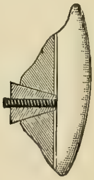


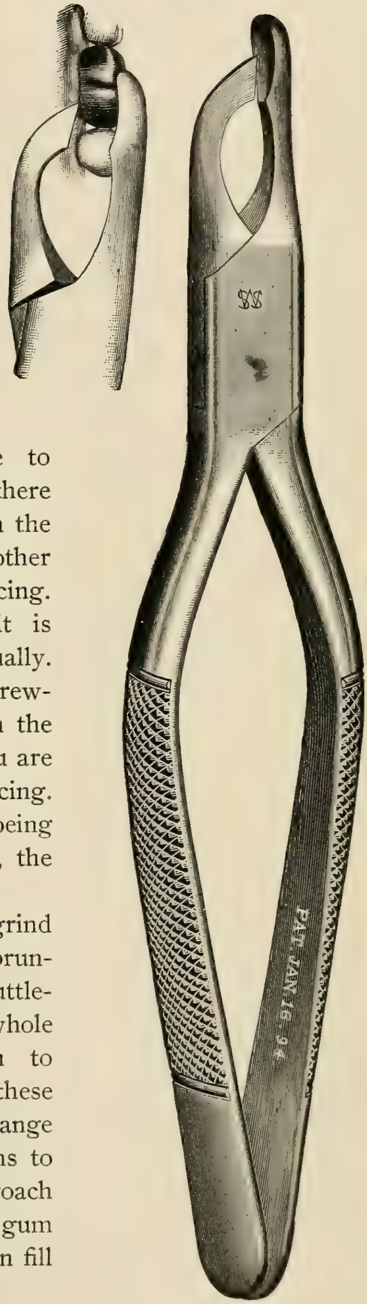
FIG. 680.



through to the front, but not far enough to enlarge the holes (Fig. 677). Now try on and fit the facing, grinding the backing or the tooth to accomplish this result. When fitted to suit, cut the threads on the pins of the facing to be used, first with the larger sized die, then with the smaller, the latter being the perfect thread and corresponding to the nuts. In cutting this thread, care should be taken not to force it too fast, and a little oil should be used, otherwise you will twist off the pins in the die, and it is difficult to remove them, besides losing the use of the facing.

Now select two nuts, and try them to see that they will go to place on the pins of the facing before putting the facing in place, laying the nuts selected in such position that you will be able to place them upon the same pin which you tried them on. Place the facing in position, holding same close and tight with the thumb of the left hand, pick up one of the nuts by inserting one of the legs

Fig. 681.



of the screw-driver into the opening (Fig. 678), carrying the nut to the pin in this manner, and starting it upon the thread, then change to the cut in the nut for the reception of the screw-driver, and screw to place, not using any force to do so, doing likewise with the other nut. When the two are in place, if they are not quite down, hold the facing firmly with the thumb of the left hand, then screw up first one nut, then the other, until entirely home. If you undertake to screw up one entirely at first, and there happens to be the least tipping upon the other side, when you screw the other nut down tight it will break the facing. Therefore you must understand it is essential to screw each down equally. Do not use undue force with the screw-driver after the tooth is home, with the idea of making it extra tight, for you are liable to pull the pins out of the facing. The strength of the threads being stronger than that of the porcelain, the latter will give first.

When the nuts are down tight, grind off the extending parts with the corundum wheel and smooth up with cuttlefish or sandpaper discs. This whole operation consumes about fifteen to twenty-five minutes' time. With these instruments you are enabled to arrange new facings where the gum happens to have receded, or where they encroach upon the gum. By baking a little gum upon the facings to be used, you can fill

any irregularities at the junction of the gum and facing, thus doing away with the open spaces usually seen in bridges consisting of the six anterior teeth. In fact, these instruments are indispensable to any dentist who does bridge-work or ever contemplates doing it. They can be used to great advantage in many other operations in dentistry, covering more ground than any other set of instruments ever devised for the use of the profession.

If the pins are bent and the nut strikes the edge, as at A, Fig. 679, straighten by pulling the nut and pin toward the side it does not strike, until it goes home (Fig. 680).

When it is found necessary for any reason to remove a crown or bridge from the mouth, it is usually desirable to do so with as little damage to the fixture as possible. The old method of mutilating the bands or caps with burs or discs is now unnecessary, since we have in the "crown-slitter"—an invention of Dr. J. B. Monfort—an instrument with which we may neatly and quickly cut the cap; then by introducing a thin chisel-shaped instrument, the edges may be so pried apart as to break up the cement and readily admit of its removal. After this has been accomplished and the fixture thoroughly cleansed, the edges, where cut, may be carefully brought together and soldered, so as to admit of subsequent replacement. This instrument and the method of using it is illustrated in Fig. 681.

CHAPTER XXXII.

ELECTRICITY, AND ITS APPLICATION IN DENTAL MECHANICS.

Historical.—Observations of electrical phenomena were made at a very early date. Thales, one of the seven sages of Greece (born 640 B. C.) is supposed to have been the first to observe that amber, when rubbed, had the power of attracting small bodies. The Greeks knew amber, when rubbed, as "elektron," from which the word "electricity" has been derived. These ancient people, however, had but little knowledge of the subject, and were quite unable to explain the few phenomena they observed.

The knowledge of electricity remained in this condition for about two thousand years, when William Gilbert, physician to Queen Elizabeth, made a series of experiments and discoveries in electrical phenomena, which won him the title of the founder of the science. "He was born at Colchester in 1540, studied at Oxford and Cambridge, afterward establishing himself as a physician in London, where he died in 1603. Considering the period in which Gilbert lived, his scientific knowledge must have been remarkable. It gained for him the favor of the queen, who gave him the means of carrying out his scientific experiments, and also appointed him her private physician. The principles and theories of Lord Bacon, who frequented Queen Elizabeth's court, probably greatly influenced Gilbert. It is, however, certain that he did not adopt the plan previously followed by schoolmen of making daring hypotheses to explain natural phenomena, but formed his ideas from direct experiment. This is exactly the plan adopted by Bacon. Gilbert discovered that other bodies besides amber could be electrified by friction. He also ascertained that the production of electricity was affected by moisture; that hot or burning bodies lost all electricity; and that an electrified body attracts a variety of other bodies, whereas a magnet only attracts steel or iron. The latter fact shows that he was acquainted with the difference between electricity and magnetism." *

* "Electricity," R. Wormell.

Then followed (about 1670) an important electrical discovery by Otto von Guericke. Up to this time electricity had been produced by taking larger or smaller pieces of various substances in one hand and rubbing them with the other. This, of course, produces very small quantities. Guericke now added, in a crude form, the electric machine. He cast a globe of sulphur and supplied it with a wooden axle, then mounted it on a frame, the hand being employed as the rubber. By means of this discovery it was learned that the production of electricity in large quantities was accompanied by light and sound. It was further noticed that the electrified sulphur globe attracted light bodies, which it afterward repelled, until they had touched some other body. At about the same time Picard observed the luminosity of greatly rarefied gases. While agitating the mercury in an imperfectly exhausted barometer tube, he produced electricity, which caused the mercurious vapor and the remaining air to glow.

Further discoveries were made by Robert Boyle and Dr. Wall —the former discovered that substances are attracted by an electrified body in a vacuum, while the latter was the first to produce the electric spark.

Stephen Gray, a Fellow of the Royal Society, and about whom little is known, discovered, early in the seventeenth century, that certain bodies were capable of conveying, or, as we now express it, conducting, electricity from one body to another. Contemporaneously with Gray, Charles F. C. DuFay, of the Academy of Sciences, was working, in France, along the same lines. He found that electrified bodies attracted the unelectrified, electrifying them in turn, and then repelling them. He also discovered the insulating properties of glass.

From this time on, through the seventeenth century, new discoveries and advances were made in electrical science. We have the work of Newton, substituting the glass ball for the sulphur globe employed by Guericke; of Gordon, who substituted a glass cylinder for Newton's glass ball; of Morrison, who devised and constructed an electric telegraph; of Kleist, who first discovered the means of accumulating and storing up large quantities of electricity. This discovery was also independently made by Muschenbroeck, of Leyden, and the name "Leyden jar," was given it. The apparatus was soon perfected, receiving its present form of a

jar coated with tin-foil, inside and out, at the hands of Sir William Watson.

One of the greatest names in the early development of electrical science is that of Dr. Benjamin Franklin, of Philadelphia. His first labors (about 1750) were in the elucidation of the theory of *positive* and *negative* electricity, which, however, was first propounded by Sir William Watson.

Franklin claimed that electricity was not created by friction, but was only transferred from one body to another. That is, "a body which becomes positively electrified receives its charge of electricity from one or more other bodies which will be found to be negatively electrified. In other words, positive electrification is due to an excess of electricity, and negative electrification to a deficiency." Franklin also set forth the analogies between lightning and the electric spark, and in some of his earliest writings he enumerates the electrical effects which were manifested by lightning. His later experiments with his kite and iron key are a matter of familiar history. A few years later (1759) Robert Symmer advanced the idea, in opposition to Franklin's theory, that there were two kinds of electricity, not, however, independent of each other, but coexistent.

Then followed, at the close of the eighteenth century, many interesting experiments by Coulomb, Galvani, and Volta. The new century opened with the accumulated evidence of the past, and soon presented Sir Humphrey Davy, Oersted, Ampère, Seebeck, and Faraday. Davy was the first to offer an explanation of the chemical action of the electric current in decomposing water, and in 1810 he produced the arc light for the first time, at the Royal Institution. He used carbon points as his electrodes, and a battery, it is said, of 2000 cells.

The discovery of the connecting link between the phenomena of electricity and magnetism was made by Oersted, of Copenhagen, who, in 1820, observed that a current of electricity flowing along a conductor deflected a magnetic needle placed near it, and his experiments were eagerly followed by Ampère, in France, who built up a wonderful mathematical theory of the magnetic action of linear conductors carrying currents. Seebeck, in 1822, opened up a most interesting department of electricity by the discovery of a method of converting heat energy into electrical energy, and he founded

the science of thermo-electricity. The last of this group is Michael Faraday, the pupil of Sir Humphrey Davy, and we owe to him the further working out of many of Davy's ideas. Faraday's name is chiefly associated with the laws of electrostatics and magneto-electric induction. The great importance of this discovery of induction may be seen by looking to the present condition of electro-technics—the telegraph, telephone, dynamo machine, etc. Faraday also substituted electrode for pole, calling the positive electrode the anode, and the negative the cathode.

From the period of Davy and Faraday on to the present time may be considered modern history in electric science, and among the names most cherished in this domain are Samuel Morse, Alexander Bell, Thomas Edison, Elihu Thompson, and Sir William Thompson, Cyrus W. Field, Edwin J. Houston, and Nikola Tesla. While we must not forget to do honor to the earliest investigators—as their labors helped to bring the science to its present position—yet the discoveries and developments which have been and are being made by our present brilliant scientists, are, in the closing years of the nineteenth century, resulting in a great social revolution. Electricity is now used and depended upon in countless departments of science, and in the arts of peace and war; in fact, no other element ministering to the good of mankind has ever proved such a versatile servant.

Electric Energy.—The fundamental principle with which we have to deal—though it was not so accepted by physicists until the middle of the nineteenth century—is the conservation of energy. For the study of dynamics, we learn that an agent that is capable of doing work possesses a certain amount of energy, and it is only due to, and so far as it possesses, this energy that it *is* capable of doing work. Examples of what is known as *actual energy* are the energy of sensible motion, as in a cannon ball, of sound-waves, of heat, etc.; of *potential energy*, that of position of a weight raised above the earth, of elasticity in a bent bow; of *electricity*, chemical combination, etc. Potential or positional energy and actual energy are in incessant interconversion; for potential energy implies force, or a tendency to motion, as much as actual energy implies motion or change of position.

From the above we learn that electricity in motion, or the electric current, is a form of energy. And this can only be procured by

the continuous expenditure of energy—as through the steam-engine and dynamo, for instance—while through or from electricity in motion various forms of energy can be procured, as in heat, light, and power. Thus, we observe the wonderful correlation of energies or forces; that is, the transformability of one form into another.

Electrical Terms.—Before going further into the subject, the student should fix in his mind a few of the most important terms adopted for designating certain principles in the management and application of the electric current. The *ampere* is the unit of current strength; that is, it is the flow produced by the pressure of one volt in a circuit whose resistance is one ohm. An *anode* is the positive terminal or electrode, *cathode* being the name given to the negative terminal. The *ohm* is the unit of electrical resistance. A *rheostat* is an apparatus for throwing a variable resistance, or number of ohms, into a circuit at will. The *volt* is the unit of electromotive *force* or *pressure,* while a *watt* is the unit of activity or rate of doing work. The activity of a circuit expressed in watts is the product of the *volts* multiplied by the *amperes*. Seven hundred and forty-six watts represent one horse-power.

Electric Dental Apparatus.—The advent of the incandescent lamp, in 1880, made electricity in dentistry practicable; it brought with it other benefits, besides the convenience and superiority of the light in the office and laboratory. It solved the problem of supply, and has done as much as any other agent to place the practice of dentistry upon its present advanced plane, and through it the dentist has the power to do more work, and to do it more conveniently, and with less discomfort and fatigue to himself and clients.

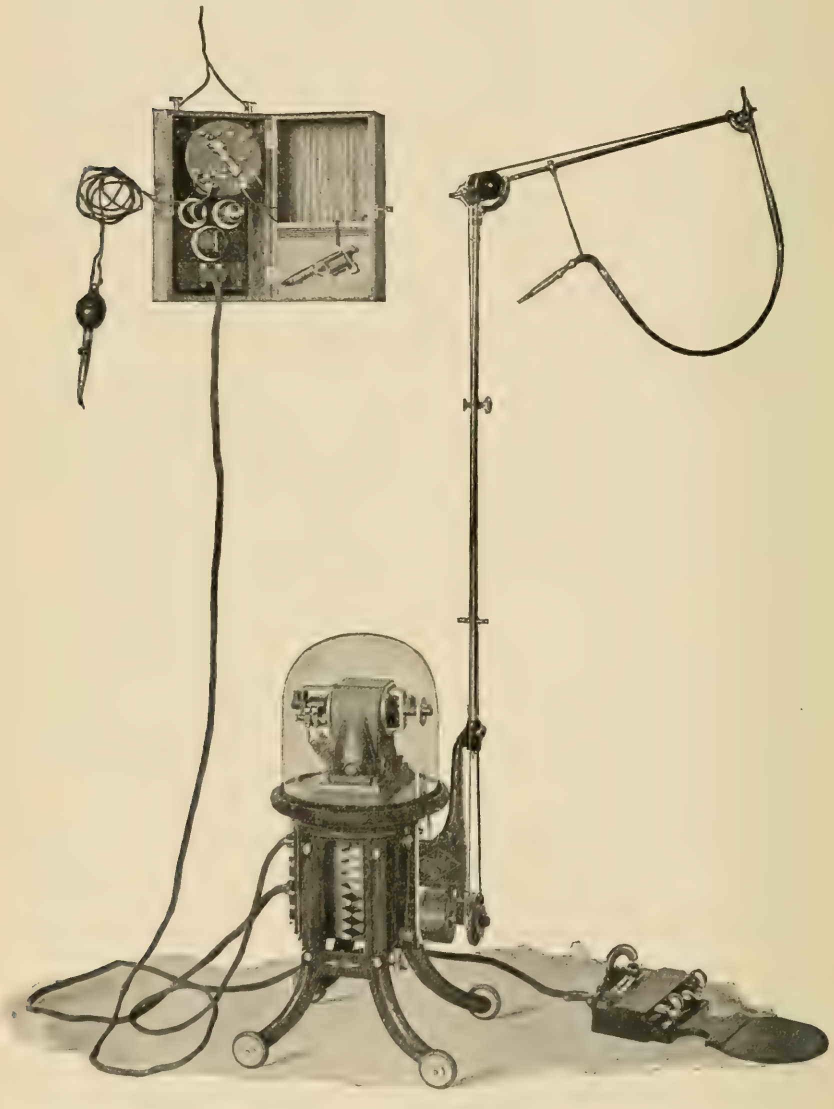
The principal electric dental apparatus may be summarized as the motor for running the laboratory lathe and office engine, the mouth lamp, root-dryer, hot-water heater, gold annealer, apparatus for producing cataphoresis, the electric oven or furnace for porcelain crown- and bridge-work, etc.

The Electric Motor.—An electric motor may be defined as a machine for converting the energy of an electric current into mechanical energy. These are manufactured in various forms and sizes according to the amount and form of energy required.

Electric Engine.—The most useful of all the electric dental apparatus is the motor-driven engine and lathe. A simple form of

motor for this purpose is shown in Fig. 682. The electro-dental engine should be as simple and light as possible, thus reducing the

Fig. 682.



moving parts to a minimum, making the bearings few and easily accessible. The motor also should be carefully mounted, so as to

minimize the vibrations. If it is fastened to the floor or a wooden stand it is advisable to insert a felt or rubber pad between the feet of the motor and the woodwork. Electric motors are supplied with rheostats, through which the power is controlled. For dental purposes these are made so as to be controlled by the foot of the operator. The later forms of these devices are so arranged that the dental engine can be stopped, started, or reversed instantly. They also give the operator the advantage of half a dozen different speeds.

The apparatus represented in Fig. 682 consists of the S. S. White dental motor No. 2, an iron stand with a mahogany top, on which it sits, a fire-proof speed-regulating resistance in an iron case supported by the stand, an electromagnetic clutch on a countershaft supported on front of stand, and a governing treadle, or rheostat, connected to it by a cable. The motor is inclosed in a glass vase to protect it from dust, and the stand is mounted upon rubber rimmed wheels to facilitate its movement from one position to another. The several speeds given to the engine-bit through this apparatus may vary from 500 to 5000 revolutions per minute. The entire control of the running of the engine is in the treadle, as previously explained.

Laboratory Lathe.—When the motor is employed for driving a laboratory lathe a different form of rheostat is used, as it is not necessary to have this machine so thoroughly under control. A rheostat and motor similar to those shown in Fig. 683 are generally employed.

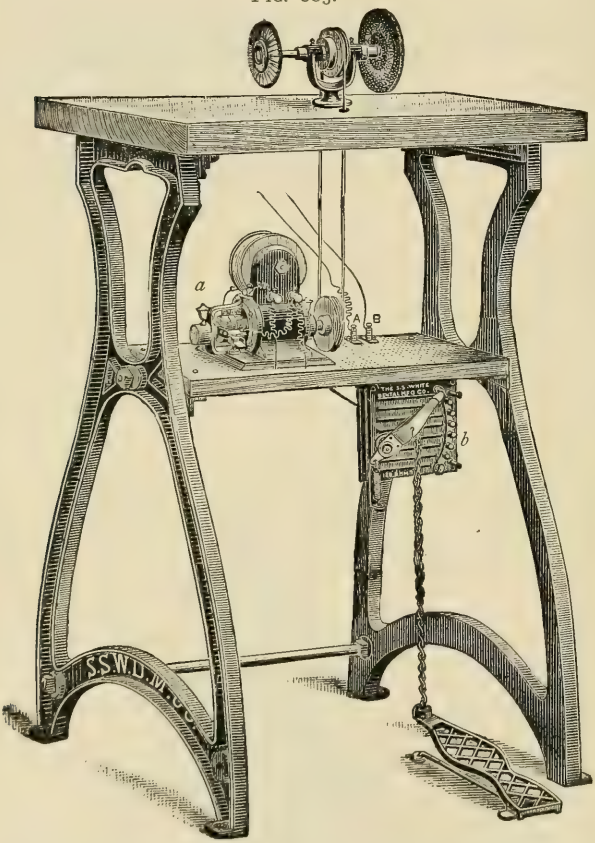
The motor shown at *a*, is of about ⅛ horse-power, which, with the 110-volt incandescent current, will run a dental lathe with more satisfaction than any other power at present known to us. The rheostat (*b*) is so arranged that the different speeds can be governed by the slight raising or lowering of the foot-pedal. The wires attached to the binding posts, A, B, are for connection with the incandescent current.

The Electric Oven or Furnace.—The utility of the electric furnace depends upon the fact that the electric current can convey energy from the outside into a closed space, and liberate it there in the form of heat. The electric furnace is available, not only for metallurgical operations, but for some of the finest of the dental laboratory procedures, as well as for chemical experiments.

A very complete furnace for metallurgical purposes in which the

electric arc is produced is shown in Fig. 684.* Ordinary electric light carbons, C C′, slide through the clamping cylinders P P′, and are brought together just over the crucible CR, at right angles to one another. For many reasons this position is found to be, for general work, more convenient than the vertical position used in

Fig. 683.

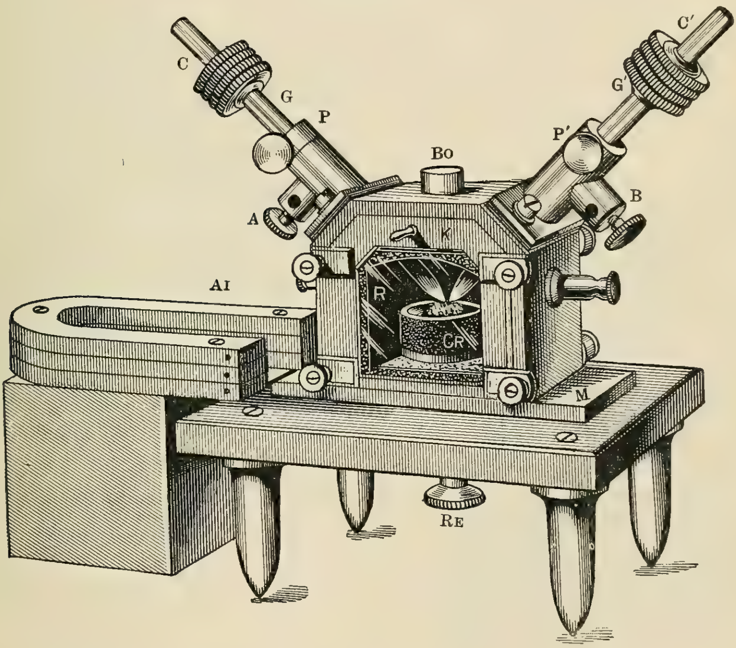


the Siemens furnace. The crucible, according to the operation that has to be performed, consists of carbon, plumbago, lime, magnesia, etc. It is in a closed refractory chamber R, with an aperture Bo at the top through which the materials to be smelted can be introduced. When large currents are used, the carbon holders P P′

* Described by Professor R. M. Wamsley, Edinburgh.

have to be kept cool by currents of water circulating through them. The front side of the furnace chamber is closed by the removable screen K, which for many purposes can be made of deep ruby-red glass, through which the operations in the crucible can be watched; but when the highest temperatures are developed it has to be made of a more refractory material. There are apertures not shown in the figure, by which, if required, gases can be introduced into the furnace. The magnet A_1 controls the play of the electric arc on

FIG. 684.



the materials in the crucible, converting the arc, if need be, into a long flame which acts as a veritable electric blowpipe. The maximum temperature attainable is about 6332° F., the temperature, according to M. Violle, at which carbon volatilizes. With a current of about 12 amperes at 55 volts the most refractory ores can be reduced in a few minutes, and pure metals can be obtained in sufficient quantities for chemical analysis. In this way, at the École Normale Supérieure, specimens of metallic ruthenium and osmium have been obtained.

The writer has had a more simple device constructed for experimental metallurgical work at the Pennsylvania College of Dental Surgery, consisting of a carbon crucible for the cathode and a carbon point for the anode. The carbon crucible is constructed so as to act both as a crucible in which metal may be fused and as a conductor for the current employed for that purpose. The carbon pencil has a small screw attachment at the upper end for the connection of the positive wire, while a similar screw, connected with the crucible, is for the negative wire. After the current has been turned on, the point of the pencil is carefully brought in contact with the bottom of the crucible, or the metal which it may contain, thus establishing the current. After this is done the pencil may be slowly withdrawn two or three inches from the metal, which will form an electric or voltaic arc. The heat of the voltaic arc is intense, and hence can be employed for fusing the most refractory substances. Platinum, for instance, can be brought to the molten condition in a few seconds.

The electric oven for fusing porcelain in crown-, bridge-, and continuous-gum-work is quite a different and more recent apparatus. In 1890 Mr. J. O'Meara devised an electric heater, consisting of a muffle of fire-clay, with wires imbedded in the same, and patented the combination of a furnace with a rheostat. This patent was purchased by Dr. H. C. McBrair, and is incorporated in what is now known as the "McBrair furnace," evidently the first to be devised and employed for fusing porcelain, and is very complete and satisfactory for dental laboratory work. This furnace is shown, with the rheostat to control the current, in Fig. 685. The electric furnace has several advantages over every other form of apparatus for similar purposes:

First.—The heat, not being the direct product of combustion, is pure, and is radiated equally from all directions within the oven; and what is known in porcelain work as "gassing" is therefore an impossibility. The ease and accuracy with which this heat can be secured and controlled is also a great desideratum.

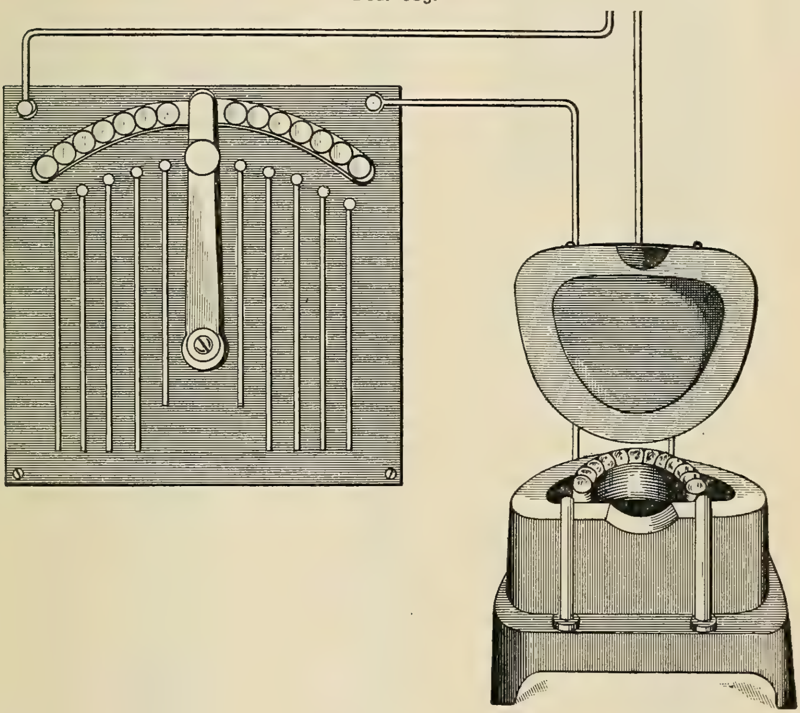
Second.—The piece to be fused can be placed in the oven without previous heating, and remain there after fusing until entirely cool. That is, the invested piece may be placed in the oven, the lid closed, and current turned on gradually by the rheostat, and when properly fused the button is turned and the work done.

Third.—The oven is small, clean, and noiseless, and can therefore be used as conveniently in the office as in the laboratory.

Fourth.—The cost of operating, compared with other methods, is reduced to a minimum.

Minor Apparatus.—The motors usually employed in the dental office are furnished with an extra pair of brushes and collecting

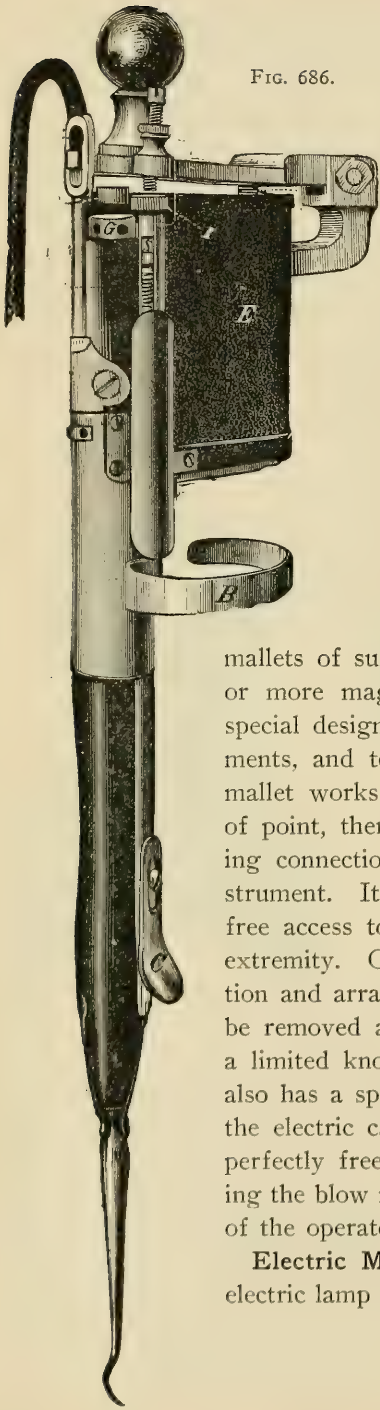
Fig. 685.



rings, and supply an alternating current, which is sent through a transformer, where, by induction, it generates a secondary current to operate the smaller apparatus, such as the electric mallet, mouth lamp, hot-air syringe, cautery, etc. These appliances, however, can be operated quite as satisfactorily from an electric battery.

The Electric Mallet.—This piece of apparatus combines the work of Drs. Bonwill and Webb in this direction. It has favor with many of the most skilful operators in the world, and by some

Fig. 686.



is thought to approach more nearly to the ideal condensing instrument than any other ever offered to the profession. This instrument is illustrated in Fig. 686.

A later form of electric dental mallet is that designed by Dr. Perry Skinner, and shown in Fig. 687. In this instrument there is no friction connected with the armature, as it stands directly over its field of magnetism, guided by the tool holder passing through its center to a point where it strikes the tool. Owing to this arrangement, as free a blow is struck as that given by a hand mallet. Previously all mallets of sufficient power were made with two or more magnets, but by using a magnet of special design one is found to meet all requirements, and to condense gold thoroughly. This mallet works by pressure on the point or side of point, thereby removing all complicated sliding connections from the hand-piece of the instrument. It also enables the operator to have free access to the electric contacts at the other extremity. Owing to the simplicity of construction and arrangement of these contacts they can be removed and replaced by any person having a limited knowledge of electricity. This mallet also has a specially designed connection (*a*) for the electric cable, which gives the instrument a perfectly free motion. The adjustment regulating the blow is very simple and under the control of the operator.

Electric Mouth Lamp.—With this miniature electric lamp (shown in Fig. 688) the dentist has

a means for exact diagnosis in certain pathological conditions of the teeth, which, with ordinary means, are difficult to locate. It lights up the mouth so effectively that a hidden cavity of decay,

Fig. 687.

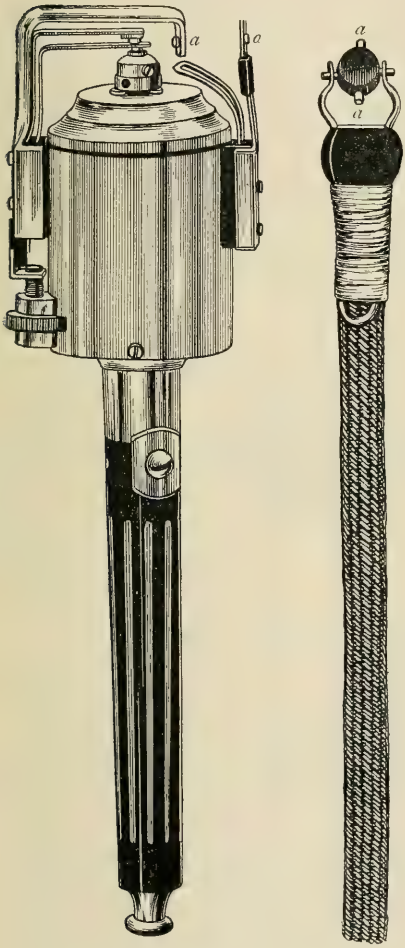
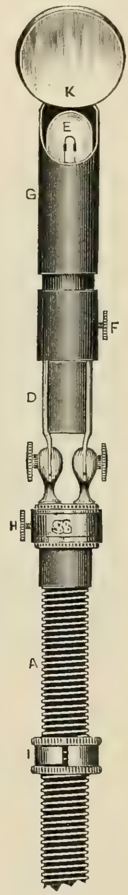


Fig. 688.



an unsuspected devitalized pulp, or any deviation from normality in the body of the teeth will be readily discernible. With the electric lamp placed back of the teeth, those that are sound will appear translucent, without variations in structure, while a devital-

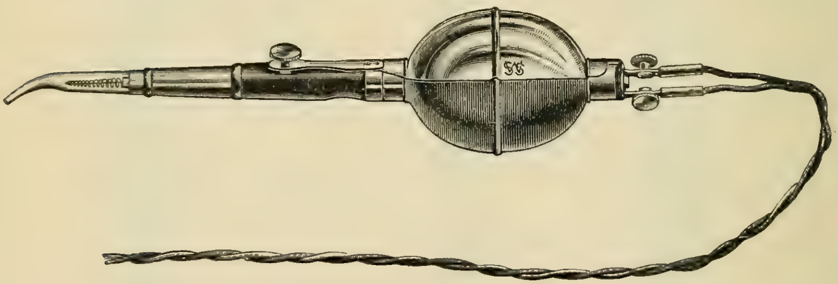
ized tooth will appear opaque, even when to ordinary observation its color gives no such indication.

Electric Hot-air Syringe.—The value of the hot-air blast in dental operations is recognized by all intelligent operators, and when the manufacturers produced an apparatus for generating this through the agency of the electric current, they gave us a neat, convenient, and time-saving instrument. The appearance of the appliance can be seen by referring to Fig. 689.

A switch under the thumb makes the circuit and gives the dentist, on compressing the rubber bulb, an instant current of heated air, which can be regulated from slightly warm to the hottest blast.

Different sized nozzles can be screwed on, giving fine or diffused jets of air; and as glass is a poor conductor of heat, the handle remains cool while the air loses none of its heat.

FIG. 689.



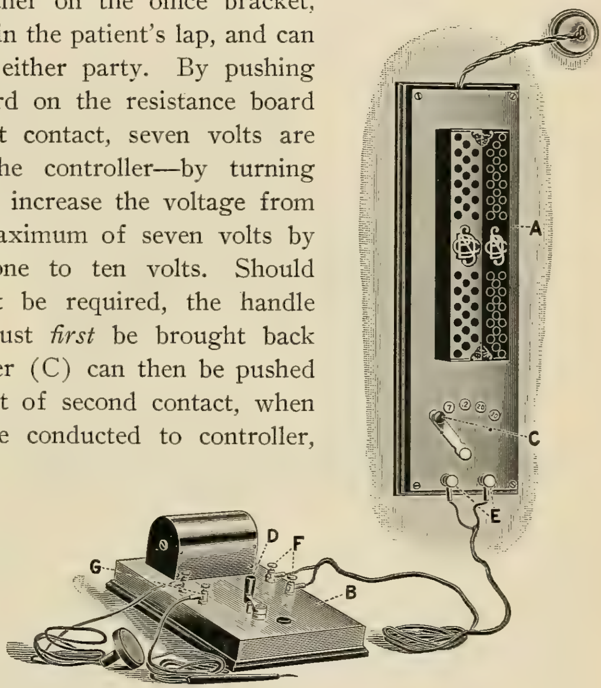
Cataphoric Apparatus.—The medication of tooth structure by electric osmosis, or, as it is generally known, "cataphoresis," has taken a very important place in dental therapeutics, and we believe that in the hands of intelligent and careful operators it will prove one of the most important discoveries ever made in the field of dental science. We say in the hands of "intelligent and careful operators" for the reason that to practise it intelligently requires as great a breadth of knowledge as any other process in dental or medical practice. It requires a knowledge of the principles under which electricity operates, and the conditions necessary for its successful application; a knowledge of the control of the agent, of resistance, and of electrolysis.

Through the employment of electric osmosis, the most sensitive

dentine may be obtunded, living pulps be painlessly removed, or discolored teeth may be readily bleached. Numerous forms of apparatus have been devised for the application of this process, which have proven more or less successful. It will answer our purpose here, however, to illustrate two of the most simple and effective, yet offered to the profession. Fig. 690 shows an excellent instrument for the utilization of the street current.

The resistance board (A) is hung on the wall, in a convenient position for operating—the controller (B) being placed either on the office bracket, or, if preferred, in the patient's lap, and can be operated by either party. By pushing the lever forward on the resistance board to point of first contact, seven volts are conducted to the controller—by turning handle (D) you increase the voltage from nothing to a maximum of seven volts by gradations of one to ten volts. Should stronger current be required, the handle on controller must *first* be brought back to zero; the lever (C) can then be pushed forward to point of second contact, when 12 volts will be conducted to controller, and so on to 30 volts. The simple movement of handle (D) will then be all that is necessary.

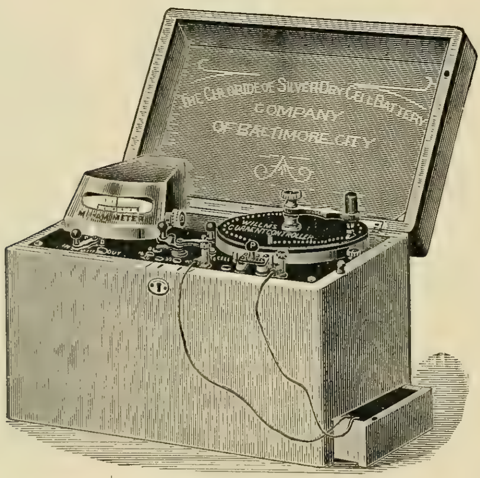
Fig. 690.



The Dry Cell Battery System.—In the next illustration, Fig. 691, is shown the ideal instrument for the employment of the battery system. Some of the advantages of this apparatus are compactness, cleanliness, constancy of current, and durability; the weight of each cell, too, being only about two ounces, 25 or 50 of them, with the case, meter, current controller, electrodes, etc., make it perfectly portable. These cells being hermetically sealed admit of no leakage; and should one of the batteries be tipped over, an accident

likely to happen to any instrument of the kind, it can remain in a reversed position for an indefinite period of time without being injured in the slightest. Then, again, as caustic and corrosive liquids do not enter into the composition of the cells, the batteries *remain clean at all times,* and connections cannot become corroded so as to interfere with the circuit. The simplicity of mechanism and absence of parts likely to wear prevents any necessity for repairs, so that the life of this battery is *only limited by the actual amount of work done.* The strength of the chlorid of silver cell is

Fig. 691.



fixed and constant, each cell representing one volt. They are also very readily removed, so that any one can readily fit out a 50-cell battery with an entire new set of cells, or replace any one cell in a series with a fresh one in a few minutes without disturbing the balance. Other features of this outfit are its meter for measuring the current and the rheostat for controlling the same. The latter permits of administering the current smoothly and with the greatest minuteness of dosage. With these two adjuncts the current is manipulated to a nicety, the *patient* not being used as a meter, as is too often the case.

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